The Cost of Doing Nothing

The Economic Case for Transportation Investment in Massachusetts

Prepared by:
AECOM

Prepared for:
The Boston Foundation
Massachusetts Competitive Partnership

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Prepared with the assistance of A Better City

January 2013

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Preface

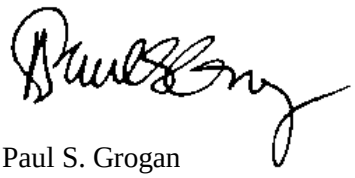
Prior to a monumental infrastructure project 150 years ago, the neighborhood where we compose this letter, Boston's Back Bay, was, in fact, a bay. Now it is one of Boston's most vibrant areas and considered to be one of the best-preserved examples of 19th-century urban design in the United States. It is filled with shops, hotels, cultural institutions and major office buildings—all of which generate considerable economic activity for the city, state and region.

The Back Bay was a big idea and a massive investment. But today, big ideas give us pause. Some of our skepticism comes from experience, as we look back at several of the disastrous projects that came about under the umbrella of "urban renewal," for example. There is no question that creating something like the Back Bay today would be difficult from a legal, financial and logistical standpoint. But would we even have the foresight and courage to make such an investment?

In past decades, future-focused investments were a significant portion of our nation's spending and responsible for innumerable accomplishments, including social innovations that broadened access to the middle class. Where would the country be today without the New Deal, the GI Bill or the interstate highway system? However, today's public sector is increasingly focused on entitlements and the "maintenance costs" of an aging population, with little left over for forward-looking investments. In the 1960s, approximately 14 cents of every federal dollar not going to interest payments was spent on entitlements; today it is 47 cents. Nowhere is this change in spending priorities more apparent than in the Commonwealth's transportation infrastructure.

Competing funding priorities and strained government coffers have limited the resources we have to invest in maintaining and expanding upon the transportation assets already in place—and in enhancing or upgrading the system to keep pace with our growing and evolving economy, which is constantly placing new demands on it. Although Massachusetts currently has a robust, multimodal transportation network, its infrastructure is one of the oldest in the United States. The age and condition of this infrastructure represents a challenge to our transportation system's effectiveness, which in turn could seriously restrict the Commonwealth's economic potential.

This report illuminates the consequences of failing to invest in our transportation infrastructure, which, without new resources, will continue a downward spiral. We expect this will be of interest to a wide range of business, civic and other stakeholders, since our transportation system—and its effect on the fiscal health of the Commonwealth—has a direct impact on all of us. We invite you to read this report and to work with us and other stakeholders to develop a response to the tremendous challenges it presents.



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EXECUTIVE SUMMARY

Massachusetts is at a crossroads. There is no doubt that the Commonwealth is recovering from the recession at a pace that is among the fastest in the nation. Job growth is improving, the economy is back on track and the future looks bright, but there is a serious problem that could stop this growth in its tracks. If Massachusetts does nothing to repair and improve its transportation infrastructure, the current recovery could easily stall. This is not just a problem for Greater Boston. Rather, it imperils jobs and economic growth throughout the entire state. Simply put, the Commonwealth's transportation network is essential to its vitality, competitiveness and quality of life.

Today's transportation network is the cumulative result of a long history of past investments, but the continued quality of the system is in jeopardy. Competing funding priorities and strained government coffers are limiting the resources available to maintain the existing assets in a state of good repair and to expand and upgrade the system to keep pace with the Commonwealth's economy as it grows and evolves. Failure to maintain the system and accommodate growth yields a strained transportation network with rising levels of road and transit congestion, potholes that are patched but not rebuilt, disabled transit vehicles that strand travelers and declining system reliability.

There is a cost to doing nothing to address this challenge that goes beyond the day-to-day aggravation of an overburdened transportation system. As the Commonwealth system's state of good repair deteriorates through underinvestment, it imposes a cost on the economy in terms of rising congestion, reduced reliability and higher operating costs. Like a private firm, the productivity of an economy is influenced by its level of investment.

This report details transportation's critical role in Massachusetts: the benefits that highways, bridges, railroads and transit bring to the Commonwealth's economy, its residents and businesses. This Executive Summary summarizes the findings. The body of the report will detail the methodologies used and will discuss the results in more detail.

Massachusetts has a history of investment in its transportation infrastructure.

Past transportation investment has yielded the diverse network in use today. Massachusetts' transportation infrastructure is an effective network of critical highways, bridges, railroads and transit systems that connect the state's economy to the global economy through its air and seaport gateways. The value of the Massachusetts Department of Transportation's capital assets, defined as roads, bridges, ramps, tunnels and similar items, is more than $18 billion net of accumulated

depreciation.[1] Built over many decades when costs were lower, the replacement cost for the system is much greater than its depreciated value suggests. The following highlights some of the more important and unique facets of the Commonwealth's multimodal system available today because of this pattern of past investment.

- The ***Massachusetts Turnpike***, now part of the MassDOT Highway Division, is Massachusetts' segment of Interstate 90, the transcontinental highway ending in Seattle. Revenue from tolls, rather than state or Federal tax revenue, paid for the bonds sold to finance the Massachusetts Turnpike's construction. Built incrementally over the past 55 years, the Turnpike is a critical artery that spans the Commonwealth. Construction of the original 123-mile segment ran from 1955 to 1957. The Turnpike expanded in the early 1960s with the 12-mile Boston extension. In 1968, the Turnpike expanded further as the segment between Interchange 9 in Sturbridge and Interchange 12 in Framingham was widened from four to six lanes (three in each direction). Exit 11a that connects to Interstate 495 opened in 1969, allowing millions of vacationers destined for Cape Cod, New Hampshire and Maine the ability to use the facility, save time and help to maintain a thriving tourist economy in coastal Massachusetts.

  Investment and expansion continued through the 1990s; the Turnpike opened the Ted Williams Tunnel, a harbor tunnel crossing from South Boston to East Boston constructed as part of the Central Artery/Tunnel Project in 1995. This third harbor tunnel doubled traffic capacity between downtown Boston and Logan International Airport in East Boston and cut in half the average travel time between the I-90 – I-93 junction and Logan Airport for most of the day.[2]

- Massachusetts' legacy of public investment has yielded more than capital assets—it has developed innovative ways of delivering projects as well. The historic $3 billion ***Patrick-Murray Accelerated Bridge Program*** represents a monumental investment in Massachusetts bridges. The eight-year program will replace or repair more than 200 structurally deficient bridges. MassDOT and its partner, the Department of Conservation and Recreation (DCR), will rely on the use of innovative and accelerated project development and construction techniques. Since 2008, the number of former MassHighway and DCR structurally deficient bridges has dropped from 543 to 437, nearly a 20% decline. Even with this creative program, the Commonwealth will still have a significant backlog of deficient bridges after the program is complete.

- The ***Massachusetts Bay Transportation Authority (MBTA)*** was one of the first combined regional transportation planning and operating agencies to be established in the United States. Founded in 1964, the "T" builds on several centuries of mass transit operations in Boston, making it one of the oldest, if not *the* oldest,

[1] Massachusetts Department of Transportation, *Financial Statements and Supplementary Schedules*, June 2011, Section 3 Capital Assets, page 27.

[2] Economic Development Research Group, Inc., *Transportation Impacts of the Massachusetts Turnpike Authority and the Central Artery/Third Harbor Tunnel Project*, February 2006.

continuously operating mass transit system in the U.S., when its legacy organizations are considered. Originally serving 14 cities and towns, the network has grown to become the nation's fifth largest mass transit system, serving 176 cities and towns with an area of 3,249 square miles. The average weekday ridership for the entire system is approximately 1.3 million passenger trips, one of only six agencies carrying more than a million passengers per day.[3] In November 2012, ridership was up for the 20th time in the last 22 months,[4] despite a fare increase introduced in July 2012 that raised fares on average by 23%[5] – a strong indication of the importance of transit as a primary mode of travel for many residents.

- Fifteen ***Regional Transit Authorities*** (RTAs) are responsible for administering public transportation services in Massachusetts outside of the Boston metropolitan area. This represents a significant expansion since the state statute created the eight original RTAs in 1974. The RTAs serve 256 of the Commonwealth's 351 communities[6] with a fixed route ridership of more than 27 million and a demand response ridership of more than 2 million. The Commonwealth's RTAs carry more passengers than the transit systems of Orlando, Buffalo, Riverside and Tucson.[7]

- With a strong maritime legacy, water transportation continues to be a component of the mobility network of Massachusetts, even as the focus has transitioned from a working waterfront in many cases to recreational and scenic uses. The ***Commonwealth's ferry system*** provides a means for visitors and commuters to bypass congested roadways to access downtown Boston. Ferry services are the lifeline to the islands of Nantucket, Martha's Vineyard and Cuttyhunk and allow the tourist industry to flourish during the summers—sustaining these economies.

But the flip side of being an innovator and first among states is that the Commonwealth's public stock of infrastructure is older than average with rising needs for recapitalization to replace and modernize facilities and bring them up to modern design standards. ***Both the MBTA and major sections of the Commonwealth's interstate system are more than 50 years old.*** The 2007 Transportation Finance Commission, an independent body of transportation experts and business and civic leaders created by statute to examine and evaluate the financial health of Massachusetts transportation agencies and authorities, concluded that the Commonwealth's transportation system had been inadequately maintained for decades. This view is underscored by the recent reports of loose wall panels in the Callahan and Sumner Tunnels and increasing numbers of disabled trains in severe winter conditions. The 2007 Commission estimated that it would require ***at least an***

[3] APTA, Ridership Report, 3rd Quarter of 2012.

[4] http://www.boston.com/metrodesk/2012/12/26/mbta-ridership-increases-again-november/L1Ie483X4J1eW8xgCMnbUL/story.html

[5] http://www.boston.com/news/local/massachusetts/articles/2012/06/30/mass_commuters_brace_for_steep_mbta_fare_hike/

[6] Astrid Glynn, "Fixing Transit Finance: A Framework for Discussion," A Better City Research Paper, April 2011.

[7] MassDOT RTA ScoreCard, December 2009. Demand response service includes paratransit.

additional $15 to $19 billion in funding, above projected revenues, ***to bring its existing surface transportation system to a state of good repair*** and maintain it at that level. This estimate excluded expansion in capacity and/or service levels to accommodate population and workforce growth.

Massachusetts is at a crossroads.

Competing funding priorities, strained government coffers and the transportation system's substantial debt burden have limited the resources invested in maintaining the transportation assets in place and in expanding / upgrading the system to keep pace with the Commonwealth's economy as it grows and evolves—placing new demands on the system.

Although Massachusetts currently has a robust, multimodal transportation network, the infrastructure is, as mentioned, among the oldest in the U.S. The age and condition of much of this infrastructure represents a challenge to maximizing the effectiveness of the transportation system, which in turn could restrict the economic potential of the Commonwealth if not addressed. This is particularly critical in 2013, as both the local and national economies are facing an uncertain recovery. Massachusetts has proven to be resilient during the recession, and while FY 2014 shows an improving revenue picture, the state is still a long way from experiencing the same level of revenue growth as it did prior to the recession. ***Continued recovery and strong economic performance may be compromised by an under-maintained transportation system and the inability to expand and accommodate future economic growth***.

The Commonwealth's high level of transportation debt as compared to other states, the inability of MassDOT and the MBTA to fund their full state of good repair needs and the growing operating deficits of the MBTA and Regional Transit Authorities are placing an ever-increasing pressure on the transportation system.

- ***State of good repair needs are growing; Massachusetts is unable to keep up with funding its current infrastructure maintenance needs.***
  - MassDOT has shown that $1 billion per year is needed for the Metropolitan Highway System Capital Maintenance Program, however, only $400 million is currently programmed annually.[8]
  - Massachusetts cities and towns also face a shortfall in the ability to maintain their streets and bridges in a state of good repair. The Massachusetts Municipal Association puts the total need at $562 million/year, while Chapter 90 only provides $200 million per year – resulting in an annual shortfall of $362 million.[9]

[8] Massachusetts Department of Transportation, *Capital Investment Plan FY 2011-2015*, 2010.
[9] Massachusetts Municipal Association, *MMA Study: Cities and Towns Need a Dramatic Increase in Chapter 90 Funding to Repair Local Roads*, MMA Special Report, December 18, 2012.

- MassDOT has approximately $240 million in operating expenses being capitalized.
- The MBTA backlog of good repair projects is at least $3 billion.
- The 15 state RTAs are also facing a state of good repair backlog of $150 million, largely due to an aging fleet.[10]

- ***Debt service payments represent a large portion of Massachusetts' annual transportation spending.***
  - In FY 2012, 45% of the MassDOT and MBTA operating budgets went to pay off debt.[11]
  - MassDOT receives $648 million in federal funding. Of that, $159 million (nearly 25%) immediately goes back to the federal government to pay off the "Grant Anticipation Notes" used to finance the Big Dig and the Accelerated Bridge Program.[12]
  - The MBTA is borrowing $470 million per year to cope with a state of good repair backlog that exceeds $3 billion.[13]
  - The MBTA has $8.6 billion with interest in outstanding debt. Of this debt, $3.6 billion was inherited from the Commonwealth in Forward Funding, including the so-called "Big Dig debt" for transit commitments related to the Central Artery project.[14]
  - MBTA debt service payments were $448.2 million in FY 2012 and 30 cents of every dollar in revenue goes to pay debt. Debt service is roughly equal to fare box revenues and to the T's entire payroll.[15]

Failure to maintain the transportation network creates uncertainty about future conditions and costs. This leads to a loss of business confidence and a reluctance to invest and expand, limiting economic development. When firms consider building new offices and factories, they take into account the long-term commitments to operate in that location. Rising congestion and deteriorating network reliability are signals that future business conditions may be more challenging, leading potential investors to consider other locations.

Where we stand now.

Setting aside the deteriorating age and condition of the system, ***projected growth highlights the need for operational improvements and capacity expansion***. Congestion is not limited to the road system.

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[10] A Better City, *Policy Position Paper on MBTA Fare Increase*, March 2012.
[11] Transportation for Massachusetts, *Maxed Out: Massachusetts Transportation at a Financing Crossroad*, October 2011.
[12] Ibid.
[13] MBTA, MBTA Fare and Service Changes: Join the Discussion, January 2012.
[14] Ibid.
[15] Ibid.

- **Highway and roads**
  - Highways and roads in Massachusetts supported more than 54.5 million vehicle miles traveled in 2010, which included 37.9 billion ton-miles of shipping by truck with a value of $297.9 billion (in 2007 dollars).
  - The volume of traffic is projected to rise by 37% over the next 40 years for a total of 86.5 billion vehicle miles traveled in 2050.
  - Goods moved by truck account for 239 million tons, or 87%, of all freight movements in Massachusetts. In line with those same trends, ton-miles of shipping by truck are expected to increase to 82.6 billion by 2040, a 128% increase. The value of truck shipping is expected to increase by 123% to $663.8 billion (in 2007 dollars).
- **Freight**
  - Freight volumes are projected to increase by 70% by 2030, with freight loads and facilities getting larger and most freight still moving by truck.[16]
  - At the same time, Massachusetts' multimodal freight transportation infrastructure is aging and struggling to compete due to congestion, clearances (from older bridges, overpasses and tunnels that were not designed for today's freight movements) and weight restrictions (particularly on older infrastructure rail).
  - Since freight transportation activity often conflicts with other land uses, many of these issues and potential solutions are inherently linked to passenger transportation.
- **MBTA**
  - The MBTA has a limited ability to add capacity to meet projected ridership growth over the next two decades.
  - The MBTA's congestion problems raise concerns that potential MBTA riders will be forced to take autos for their travel, adding to road congestion.
  - It also means that future transit-oriented development could be impeded by lack of capacity—pushing economic development out to the periphery of the Boston region or to other communities. Key areas of concern include: Downtown Boston, Back Bay, the Longwood Medical Area, the Seaport and Kendall Square. Because of the "hub and spoke" nature of the MBTA transit system, transit congestion in these core locations can affect future transit-oriented development along the outer "spokes" of the system as well.[17]
  - The Authority's fleet consists of some older locomotives, nearing the end of their useful lives, and others that are in great need of overdue top-deck overhauls. Between Fiscal Years 2011 and 2025, the MBTA projects that all 80 of the current locomotive revenue fleet will be due for retirement based on a 25-year service life and will need to be replaced.[18] This has had a noticeable effect on the reliability of the commuter rail system fleet. The mean number of miles between failures, a barometer of reliability, has been gradually dropping and now stands at about half the system goal of 10,000

[16] Massachusetts Department of Transportation, State Freight Plan, September 2010.

[17] Stephanie Pollack, "Hub and Spoke Core Transit Congestion and The Future of Transit and Development in Greater Boston," Urban Land Institute, 2012.

[18] 2011 – 2025 MBTA Commuter Rail Fleet Management Plan, p. 9-1.

miles between failures.[19] Obtaining funding for and carrying out scheduled overhauls and vehicle replacements are critical to ensuring reliable, on-time passenger service and maintaining the market.[20]

- **RTAs**
  - While Massachusetts RTAs are not as capacity-constrained as the MBTA system, they struggle to provide non-peak service with regular headways.
  - Such services are essential for workers to be able to use the service as a regular means of commuting in an increasingly 24/7 economy, limiting the potential of transit to be a reliable alternative mode to the auto in these communities.

There is a cost to doing nothing.

When the system's physical qualities do not efficiently accommodate the movement of goods and people, performance deteriorates and imposes a cost—a severe penalty—on the Commonwealth's economy. This cost can occur through a variety of means as described below.

- Facilities that are not in a state of good repair lead to increases in operating costs for cars, trucks and railroads and heighten the likelihood of crashes—translating into costs associated with property damage, injury and loss of life. By 2030, these operating and safety costs are expected to total $6.6 to $11.1 billion (in discounted 2008 dollars).[21]

- Increased congestion translates into greater travel times, diverting valuable time from productive work or the non-work activities that support a high quality of life. By 2030, these losses in travel time are expected to cost the Massachusetts' economy between $11.1 and $14.9 billion (in discounted 2008 dollars).

- The diversion of additional resources to mitigate rising congestion and operating costs shifts resources to dealing with these problems, reducing the productivity of business in the Commonwealth. This translates into losses in income and jobs. It is estimated that between 12,300 and 15,600 jobs will be lost in Massachusetts due to its deficient highway transportation network by 2030.

- Travelers' efforts to avoid highly congested points of the network—bottlenecks for example—can lead them to travel longer distances.

- Rising congestion and bottlenecks erode travel reliability, increasing the amount of time commuters and shippers must allow to achieve on-time delivery. To

[19] MassDOT. MBTA ScoreCard. September 2012.
[20] 2011 – 2025 MBTA Commuter Rail Fleet Management Plan
[21] Values are discounted in order to report current and future benefits in a common metric, a net present value. Benefits received in the future are worth less than benefits received now because of the opportunity cost associated with having to wait for the benefit.

compensate, some shippers will hold higher inventories, raising their overall business costs as a result of the transportation system's performance.

- Deteriorating system performance translates into vehicles that are not operating at their most efficient levels—yielding environmental costs. The environmental consequences of traveling longer distances include impacts on air quality, increases in greenhouse gas emissions and rising water pollution from roadway runoff.

- There is the real concern about deferred maintenance on the system and safety, but there is also an impact on the cost. Fixing the system in the near term can help Massachusetts avoid cost growth in the future. Based on historic trends, it is expected that the cost of construction will grow by 3.2% per year,[22] with 10 years from now producing a compounded cost that is 37% higher than today. There is an additional concern that constrained state and federal revenue growth may lag cost growth, aggravating the problem.

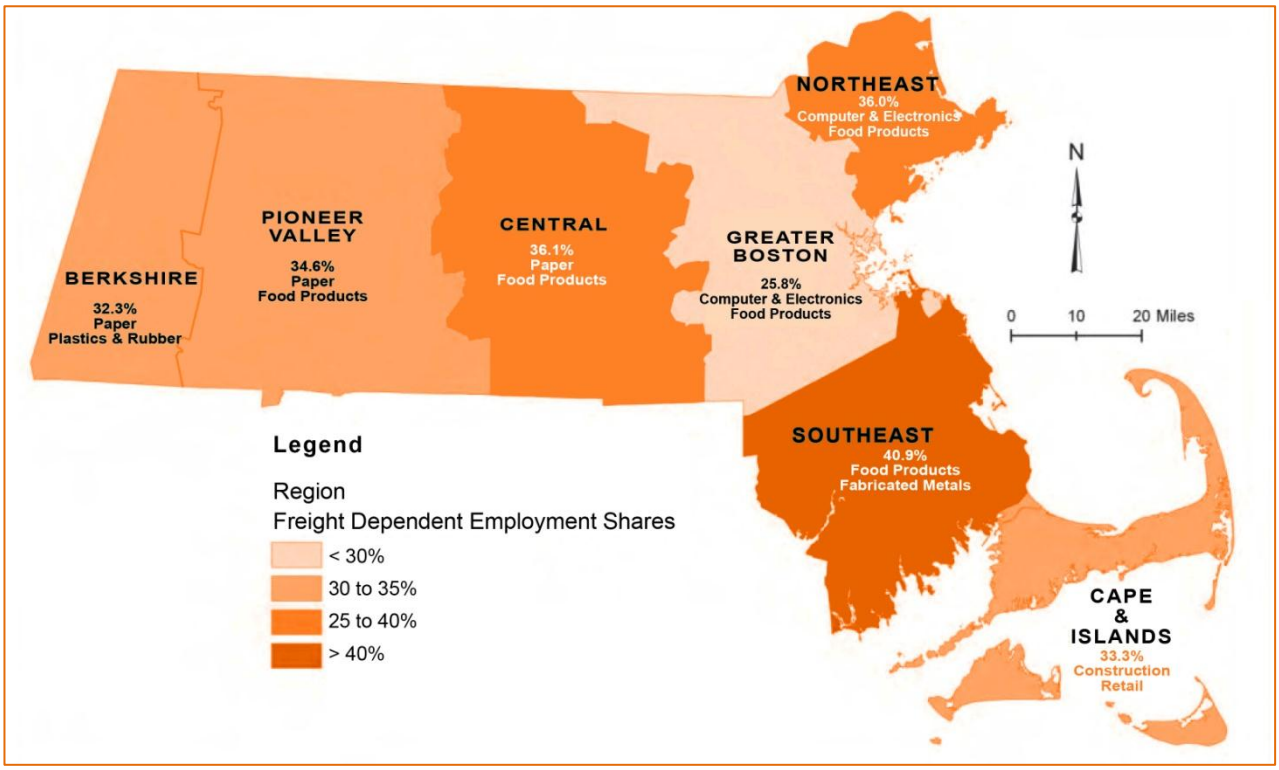
This report describes and focuses on how losses of transportation system performance affect the performance the Massachusetts economy. Because transportation infrastructure is ever-present in our daily lives and because the erosion of system performance generally happens incrementally over time, its true cost to the economy is not seen on a day-to-day basis.

This is a statewide problem.

All Massachusetts regions will feel the effects of the state's eroding transportation infrastructure. That said, there are important differences in the economic composition of each sub-state region that in turn defines the types of transportation investments needed to sustain and foster business activity in each region. For example, the eastern regions of the Commonwealth rely more on just-in-time delivery for service industries and time-sensitive manufactured goods; the western regions host greater concentrations of traditional manufacturing and thus rely on moving bulk commodities that are less time-sensitive.[23] The southeast region has the highest share of freight-dependent jobs of any region at 51 percent.[24] This is due, in part, to the existence of ports in Fall River and New Bedford, and numerous inland distribution centers.

[22] ENR, Construction Cost Index, Average Annual Growth, 1990-2011.
[23] MassDOT, *Freight Plan*, September 2010.
[24] Freight-dependent jobs include manufacturing, transportation and logistics employment. MassDOT *Freight Plan*, September 2010.

Figure ES-1: Massachusetts Freight-Dependent Employment by Region



Source: US Department of Commerce from IMPLAN, Calculations by EDR Group. Graphic from Massachusetts Department of Transportation, *Freight Plan*, September 2010.

Eastern Massachusetts

Large, complex urban areas, such as Boston and the associated Northeast Corridor megapolitan region that it helps to anchor, exist because they are focal points for commercial transactions. Urban areas provide access to large pools of labor, frequent and relatively inexpensive air transport, specialized technical and professional services and a large client base.

These factors and others provide so-called "agglomeration economies" that diminish the cost of transactions and make the urban area's firms more productive. Balanced against the advantages of urban size are the diseconomies of large urban areas; these negatives include higher living and business costs such as rents, crime and traffic congestion. As long as firms and households perceive that the advantages outweigh the negatives of a Boston location, firms and households will locate in the urban area, incur the costs and the metro economy will grow and thrive. When the negatives just equal the benefits, the urban area is at its optimal size and growth will languish. When the negatives outweigh the benefits, existing businesses choose to expand elsewhere and population growth slows.

Investments to expand travel capacity or improve the travel time of public transit service reduce the negatives associated with congestion, thus influencing the urban area's size and density of people and firms—it is a critical factor that influences sensitivity to land and labor costs. ***Absent the ability to reliably move large numbers of specialized skilled labor in, out and within the urban economy on a daily basis such as that provided by the MBTA system, Boston's and the region's economic potential is constrained. The same idea holds true for other types of infrastructure as well.*** Each infrastructure investment in the overall Boston regional travel network, expansions such as the South Coast Rail project, extensions to the existing system, or improvements to the existing system that relieve bottlenecks and add capacity at core areas expand the ability of the economy to manage density. These benefits are capitalized into the property values at the locations where the benefits are consumed, and improve access and mobility supporting the economic vitality of the region. The Boston metropolitan region's job shed extends throughout Massachusetts. Access to urban core is directly related to job retention and growth. In addition, the ability to offer a sustainable quality of life through improved transportation is thus central to Boston's and the region's ability to offset the costs of population and employment growth.

Central Massachusetts

Four industries account for 50 percent of the employment base in the Central Massachusetts region: Health Care, Education, Retail and Manufacturing.[25] This mix reflects the region's economic transition from reliance on traditional industries, such as manufacturing and logistics, to developing its own mix of knowledge industries such as health care and education. ***Supporting the region through this transition means sustaining the remaining existing industry but also fostering connections between the health care and education cluster in Central Massachusetts and that of Eastern Massachusetts.*** This regional interaction has benefits for both Worcester and Boston because as they become more integrated economically, they can begin to compete as a larger economy. It is no longer Worcester competing in the global economy or Boston competing on its own, but rather the complementary resources of both competing together. Investments such as Worcester's $32 million dollar renovation of the intermodal Union Station building is a major initiative that anchors development but also fosters a connection with Boston. The MBTA currently operates 13 round-trip trains per day between Union Station and Boston, with more to be added in the future. This train service accommodates more than 1,000 daily passengers. The bus pavilion will have a transfer hub to service approximately 230 buses a day. The transfer station design has been incorporated as part of the surrounding Innovation District. Enhancing the Worcester commuter rail corridor will also help strengthen the Worcester region's economic growth.

[25] Greater Worcester CEDS, 2012.

Western Massachusetts

A striking result of the 2002-03 "Knowledge Corridor" study was that 45% of graduating seniors planned to leave the region.[26] Home to some of the nation's leading educational institutions and a region of high-quality amenities that draw significant tourist visitation each year, the region was losing its younger generation as they sought areas with greater economic opportunity. Set against this backdrop, the focus of transportation investment in the western region is more on fostering access rather than providing capacity as in the eastern portion of the state. ***By promoting north-south access and ignoring state boundaries, the region is using its transportation investments to expand the diversity of economic opportunity within the functional region.*** For example, the Knowledge Corridor - Restore *Vermonter* Project will restore Amtrak's intercity passenger train service to its original route by relocating the *Vermonter* to its former route on the Pan Am Southern Railroad. This routing offers a shorter and more direct route for the *Vermonter* between Springfield and East Northfield and improves access to densely populated areas along the Connecticut River. The anticipated benefits, including a 25-minute reduction in travel time, an associated 24 percent gain in *Vermonter* ridership and greater reliability, collectively support economic revitalization and reduce traffic congestion by offering a reliable alternative. In Springfield, I-91 is a major north-south highway and a main artery of the Knowledge Corridor. The viaduct that carries I-91 parallel to the Connecticut River is deteriorating and will require a major investment in order to maintain access across Massachusetts and into Vermont.

Estimated Impacts.

The diversion of additional resources to mitigate rising congestion and operating costs shifts resources to dealing with these problems, reducing the productivity of business in the Commonwealth. This translates into losses in income and jobs. As mentioned, it is estimated that between 12,300 and 15,600 jobs will be lost in Massachusetts as a result of its deficient highway transportation network by 2030. This is a small fraction when compared to the total size of the state's employment base, but it is equivalent to losing one of the state's largest employers nearly every year.

To estimate the costs of not funding Massachusetts' highway state of good repair needs, the Federal Highway Administration's (FHWA) Highway Economic Requirements System – State Version (HERS-ST) model was used. These costs are measured in the model as the benefits of funding the full highway maintenance state of good repair needs in Massachusetts' Capital Investment Plan FY 2011-2015 rather than maintaining the current levels of funding shown in the plan. The HERS-ST results are summarized in the table below. It is important to note that HERS-ST does not identify improvements for bridge structure deficiencies and bike-pedestrian access; therefore, funding and needs associated with these programs are excluded from the analysis.

[26] Hartford-Springfield State of the Region 2012 Conference.

Table ES-1: Estimated Benefits of Funding Massachusetts' Highway State of Good Repair Needs Summary (2010-2030)

	Range of Savings (in Billions of Discounted 2008 dollars)*	
	Low	High
Travel Time Savings	$ 11.1	$ 14.9
Operating Cost & Safety Savings	$ 6.6	$ 11.1
Total Benefits	**$ 17.7**	**$ 26.0**

*Benefits shown are discounted using a 7% discount rate.

- By 2030, losses in highway system performance are expected to cost Massachusetts' economy between $11.1 and $14.9 billion (in discounted 2008 dollars) in lost travel time.[27]

- An additional $6.6 to $11.1 billion (in discounted 2008 dollars) in vehicle operating costs avoided and safety benefits if the highway system were in a state of good repair, which would reduce household budgets for other types of spending, such as education and health-related purchases, and recreational spending.

Productivity matters for Massachusetts—a high wage and high cost state relative to the nation—because firms are willing to pay more productive workers higher wages. Massachusetts has the highest business costs in the nation. When the benefits of high productivity no longer outweigh operational costs, employers' earnings growth will slow and firms will seek locations outside of Massachusetts for expansion or relocation. In short, the private sector of an economy that underinvests in its transportation system becomes less competitive over time.

Table ES-2: State Business Cost Comparison for Massachusetts and its Neighbors

Massachusetts and Surrounding States	Cost of Doing Business		Unit Labor Cost		Energy Cost		State & Local Tax Burden	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Massachusetts	124	1	117	1	169	3	99	19
Connecticut	113	4	99	24	183	2	111	8
New Hampshire	111	7	104	7	162	4	80	45
New York	110	9	97	29	146	8	142	1
Vermont	110	10	104	5	130	11	111	7
Rhode Island	102	14	92	39	150	6	109	9

Source: Moody's Analytics
Note: An index value of 100 means a state's costs are equal to the U.S. average. States are ranked out of 51 (50 states plus the District of Columbia). A rank of 1 is the highest cost; a rank of 51 is the lowest.

[27] Values are discounted in order to report current and future benefits in a common metric, a net present value. Benefits received in the future are worth less than benefits received now because of the opportunity cost associated with having to wait for the benefit.

Not only do transportation investments help us get around safely and reliably, move needed goods and help grow businesses and jobs, they also have their own direct economic benefits and influences. For every dollar in transportation capital investments spending, Massachusetts delivers $2.04 dollars in output, due to the multiplier effects.[28] This spending supports additional jobs and earnings in the Commonwealth.

- ***Between 2007 and 2012, annual capital transportation expenditures by MassDOT and the MBTA have created or supported 24,847 average annual person-jobs and $1.23 billion (in 2012 dollars) in earnings in Massachusetts.***
- Construction, administration and project management throughout the Commonwealth have contributed to these gains.

There are interactions among modal performance.

- Performance losses in transit can impose costs on highway travelers. As transit capacity is reached, more travelers will be forced onto the roads. Growing capacity constraints for the MBTA and the RTAs' inability to expand service limit their ability to offset or serve as a relief valve for highway congestion.
- Airports and seaports in Massachusetts are gateways to the global economy. If people and goods cannot efficiently reach these gateways, the Massachusetts economy cannot grow or sell its products to a global market.
- Given that the knowledge economy is an anchor of Massachusetts economy, the efficient movement of people is essential for it to work and compete.

Collectively, this loss of transportation performance threatens Massachusetts' ability to be a global competitor in coming decades.

- The health of the state's economic anchor relies on daily efficient movement of people in and out of Boston, the urban core, and economic centers throughout the state. Without an efficient transportation system, the daily flow of workers and goods to the dense urban market could not be achieved.
- Landside access to the state's marine ports and airports is critical to utilizing these gateways to the global economy. Air and marine carriers select ports (air or marine) with efficient inland distribution networks for imports.
- The efficient operation of the state's road, bridge and transit network is necessary for the Commonwealth to remain a dominant economy within the U.S. Northeast region.

[28] BEA, RIMS II Regional Multipliers for the Commonwealth of Massachusetts, Type II, 2010

Conclusion

This report details some of the very serious consequences of "doing nothing" about Massachusetts' transportation needs. While it focuses on the direct economic impact of a failure to act, it only alludes to the broader consequences of inaction.

While Massachusetts is outperforming our peer states in recovering from the recession, it is also operating within a global economy that is increasingly highly competitive. In order to compete effectively in this swiftly changing economic atmosphere—and continue to be a place that is attractive to businesses and residents—the Commonwealth must not only address the looming problems described in this report, but anticipate the tremendous infrastructure needs of the near and distant future.

The Boston Foundation, the Massachusetts Competitive Partnership and numerous other nonprofit, civic and business institutions must work together to address our immediate transportation needs to ensure Massachusetts' future economic growth and vitality.

CHAPTER 1:
THE MASSACHUSETTS TRANSPORTATION SYSTEM AT A GLANCE

Transportation System Overview

The Massachusetts transportation system is crucial to the Commonwealth's future economic success and a key component of the state's ability to remain economically competitive in a fast-changing global context. It provides essential access for residents, workers, visitors and businesses to markets, jobs, goods and services.

The Commonwealth has an extensive commuter and multimodal transportation system with roads and bridges, commuter and freight rail, marine transportation and more. The value of the Massachusetts Department of Transportation's capital assets, defined as roads, bridges, ramps, tunnels and similar items, is more than $18 billion net of accumulated depreciation[29]. Built over many decades when costs were lower, the replacement costs for the system are much greater than its depreciated value suggests. Its major features include:

- More than 36,000 miles of public roads[30]
- 138 miles of toll roads on the Massachusetts Turnpike owned and operated by MassDOT[31]
- 5,099 bridges[32]
- 11,972 buses operated by 16 public transportation authorities and a network of other private and public transit operators[33] [34]
- 39 commercial or general aviation airports[35]
- 896 miles of freight railroad tracks operated by 11 different railroad companies[36] [37]
- An extensive commuter rail line serving the Greater Boston area

[29] Massachusetts Department of Transportation, *Financial Statements and Supplementary Schedules*, June 2011, Section 3 Capital Assets, p.27.

[30] Federal Highway Administration, *Highway Statistics 2010*, HM-20.

[31] Ibid, HM-25.

[32] Ibid, BR-7.

[33] Ibid, MV-10.

[34] Massachusetts Department of Transportation, Massachusetts Regional Transit Authorities - Transit Division, http://www.massdot.state.ma.us/transit/RegionalTransitAuthorities.aspx

[35] Massachusetts Department of Transportation, *Massachusetts Statewide Airport Economic Impact Study, Executive Summary*, 2010, p. 1.

[36] Association of American Railroads, *Freight Railroads in Massachusetts*, 2010.

[37] Massachusetts Department of Transportation, Massachusetts Regional Freight Rail Operators - Transit Division, http://www.massdot.state.ma.us/transit/RegionalFreightRailOperators.aspx

- Several commuter ferry lines and five major seaports and several harbors of varying sizes[38]
- 152 miles of shared-use paths[39]

The transportation system in the Commonwealth is aging rapidly and becoming constrained. Both major sections of Massachusetts' interstate system and the MBTA are more than 50 years old. The 2007 Transportation Finance Commission, an independent body of transportation experts and business and civic leaders created by statute to examine and evaluate the financial health of Massachusetts transportation agencies and authorities, concluded that the Commonwealth's transportation system had been inadequately maintained for decades. This view is underscored by the recent experience with loose wall panels in the Callahan and Sumner Tunnels and increasing numbers of disabled trains in severe winter conditions. The 2007 Commission estimated that it would require at least an additional $15 to $19 billion in funding above projected revenues to bring its existing surface transportation system to a state of good repair and maintain it at that level[40]. This estimate excluded expansion in capacity and/or service levels to accommodate population and workforce growth. Annually, it is estimated that traffic congestion on the Commonwealth's highways accounts for 93 million person hours and more than half of Massachusetts bridges are either structurally deficient or functionally obsolete[41].

In the near future, the Commonwealth's transportation system will need funding for further expansions and repairs. A few examples include the following:

- $1 billion per year is needed for the Metropolitan Highway System Capital Maintenance Program. Only $400 million is currently programmed annually for the Program[42].
- MassDOT has $200 million in operating expenses being capitalized.
- The MBTA backlog of state of good repair projects is at least $3 billion[43].
- The Port of Boston alone serves 30% of New England's waterborne cargo and is the largest container port in the region. At Massport, 63% of the revenue generated comes from container handling. One long-term strategic opportunity is an improvement that would dredge to a 48-foot depth navigation access channel and a 50-foot depth entrance channel to Conley Terminal[44]. As the needs develop, a financial commitment to Massachusetts ports will become essential.
- To ensure a safe and efficient airport system in Massachusetts, an estimated $1.07 billion will be needed through 2030[45].

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[38] Massachusetts Department of Transportation, *Freight Plan*, 2010, p. 2-82.
[39] Massachusetts Department of Transportation, *Bicycling in Massachusetts*, 2012.
[40] Massachusetts Transportation Finance Commission, *Transportation Finance in Massachusetts: An Unsustainable System*, March 2007.
[41] Massachusetts Department of Transportation, *Freight Plan*, 2010, p. ES-31.
[42] Massachusetts Department of Transportation, *Capital Investment Plan FY 2011-2015*, 2010.
[43] Massachusetts Bay Transportation Authority, *Capital Investment Program, FY2012-FY2016*, 2011, p. 5.
[44] Massachusetts Department of Transportation, *Freight Plan*, 2010, pp. 2-96 and 2-109.
[45] Massachusetts Department of Transportation, *Massachusetts Statewide Airport System Plan, Executive Summary*, 2010, p. 22.

- Between 2007 and 2011, more than $39 million was invested in the construction of 23 shared-used paths covering 45 miles of new facilities. The Bay State Greenway 100 prioritizes the next 100 miles of shared-use paths and will require additional funding to support the Bay State Greenway initiative[46].

The sections below highlight the importance of each mode to the Commonwealth.

Highways, Roads and Bridges

The road network is the largest component of the Massachusetts transportation system, containing 72,000 lane miles and 5,000 bridges[47]. Of this, more than 9,500 lane miles and 3,500 bridges are owned and maintained by MassDOT and are predominantly composed of higher function classes, such as Interstates and principal arterials[48]. While MassDOT accounts for only 13% of the lane miles in the Commonwealth, its roadways carry 58% of the annual VMT[49].

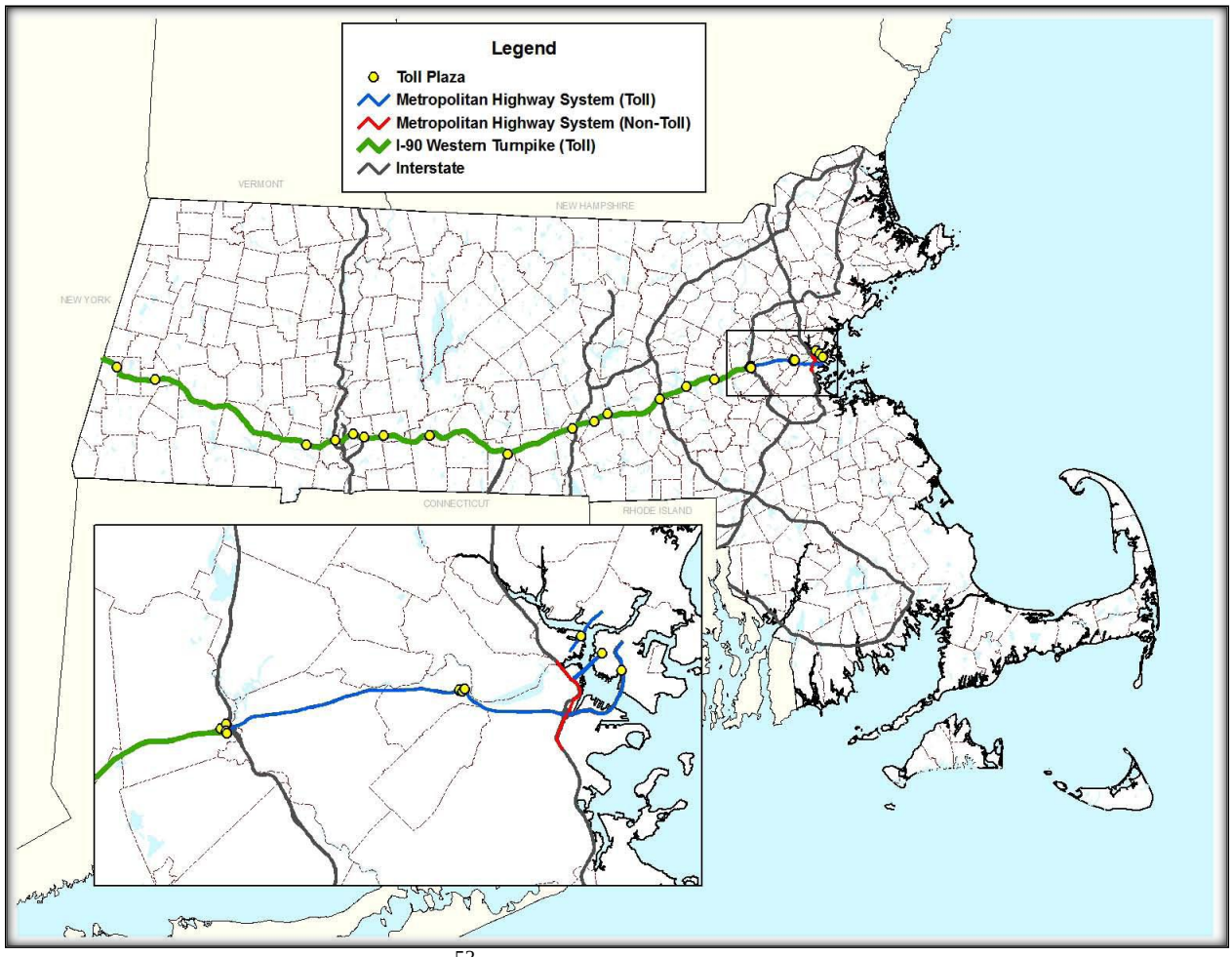
The current pavement condition of MassDOT's road system is below the agency's target rating. The average current pavement rating for MassDOT interstates is 3.5, or excellent, while the target rating is 4.0. Similarly, the average current pavement condition for MassDOT non-interstates is 3.0, or good, while the target rating is 3.5. To reach these target pavement conditions, MassDOT estimates that an additional investment of $313 million per year for the next five years would be required[50].

The historic $3 billion Patrick-Murray Accelerated Bridge Program represents a monumental investment in Massachusetts bridges. The eight year program will replace or repair more than 200 structurally deficient bridges. Since 2008, the number of former MassHighway and Department of Conservation and Recreation structurally deficient bridges has dropped from 543 to 437, a decline of nearly 20%. Even with this creative program, the Commonwealth will still have a significant backlog of deficient bridges after the program is complete.

[46] Massachusetts Department of Transportation, *Bay State Greenway Implementation*, 2011.
[47] Massachusetts Department of Transportation, *Capital Investment Plan* FY 2011-2015, September 2010, Chapter 3, p. 3.
[48] Ibid, Chapter 3, p. 8.
[49] Ibid.
[50] Ibid, Chapter 3, pp.6-7.

MassDOT also owns and maintains the assets that were once part of the Massachusetts Turnpike Authority, including the Massachusetts Turnpike (I-90 extending 138 miles from Logan International Airport to the New York border), Central Artery (depressed section of I-93 through Boston, and three Harbor Tunnels (the Sumner, Callahan and Ted Williams)[51]. Additionally, MassDOT operates the Tobin Memorial Bridge connecting the Charlestown section of Boston with Chelsea[52]. The toll facilities are highlighted in Figure 1-1.

Figure 1-1: Massachusetts Toll Facilities



Source: MassDOT Capital Investment Plan[53]

The highways and roads in Massachusetts supported more than 54.5 million vehicle miles traveled in 2010[54], which included 37.9 billion ton-miles of shipping by truck with a value of $297.9 billion

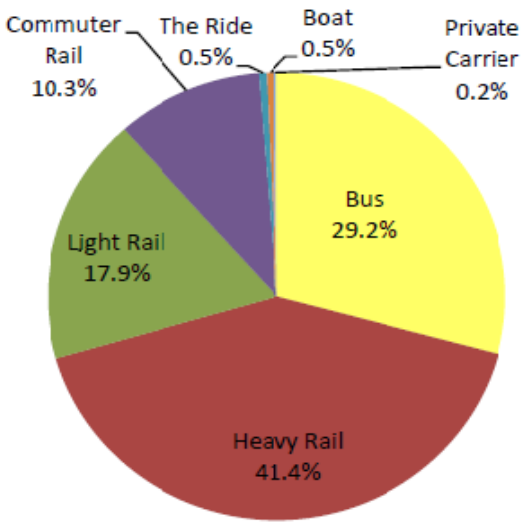
[51] Ibid, Chapter 2, p. 10.
[52] Ibid.
[53] Massachusetts Department of Transportation, *Capital Investment Plan FY2011-2015*, September 2010, Chapter 2, p.11.
[54] Federal Highway Administration, *Highway Statistics 2010*, VM-2.

(in 2007 dollars)[55]. The volume of traffic is projected to rise by 37% over the next 40 years for a total of 86.5 billion vehicle miles traveled in 2050[56]. In line with those same trends, ton-miles of shipping by truck are expected to increase to 82.6 billion by 2040, a 128% increase[57]. The value of truck shipping is expected to increase by 123% to $663.8 billion (in 2007 dollars)[58].

Transit

Massachusetts' largest transportation hub is in the city of Boston, which is served by the Massachusetts Bay Transportation Authority (MBTA). Originally serving 14 cities and towns, the network has grown to become the nation's 5th largest mass transit system, serving 176 cities and towns with an area of 3,249 square miles. The MBTA offers approximately 200 bus routes, subway, commuter rail and ferry boats throughout the region, serving approximately 1.3 million riders on a typical weekday[59]. The MBTA is one of only six agencies carrying more than a million passengers per day. The breakdown of ridership by mode is shown in the chart below. The dominant share of ridership uses heavy rail (subway) followed by bus and light rail.

Figure 1-2: MBTA Ridership Breakdown by Service Type



Source: MBTA ScoreCard[60]

[55] Federal Highway Administration, *Freight Analysis Frame Work*, FAF3.4 State summary by Dmsmode and Trade, 2007 and 2011.xlsx.
[56] Ruder, Adam, "Smart Growth Opportunities for Reducing Greenhouse Gas Emissions in Massachusetts." Diss. Harvard University, 2008.
[57] Federal Highway Administration, *Freight Analysis Frame Work*, FAF3.4 State summary by Dmsmode and Trade, 2040.xlsx.
[58] Ibid.
[59] APTA, *Ridership Report*, 3rd Quarter of 2012.
[60] Massachusetts Bay Transportation Authority, *MBTA ScoreCard*, 2012. http://www.mbta.com/about_the_mbta/scorecard/

The map below shows both the subway system (Rapid Transit Line) and Commuter Rail lines and the extensions into neighboring communities.

Figure 1-3: MBTA Commuter Rail and Rapid Transit Lines

Source: MBTA

Fifteen Regional Transit Authorities (RTAs) are responsible for administering public transportation services in Massachusetts outside of the Boston metropolitan area today. The additional public transportation authorities in the Commonwealth offer buses and paratransit services for the community's needs, often linking to MBTA or Amtrak stations on the Northeast Corridor (NEC) and Knowledge Corridor. This represents a significant expansion since the state statute created the eight original RTAs in 1974. The RTAs serve 256 of the Commonwealth's 351

communities[61] with a fixed route ridership of more than 27 million and a demand response ridership of more than 2 million. The Commonwealth's RTAs carry more passengers than the transit systems of Orlando, Buffalo, Riverside and Tucson[62]. These Regional Transit Authorities (RTAs) are:

- Berkshire Regional Transit Authority (BRTA)
- Brockton Regional Transit Authority (BAT)
- Cape Ann Transit Authority (CATA)
- Cape Cod Regional Transit Authority (CCRTA)
- Franklin Regional Transit Authority (FRTA)
- Greater Attleboro Taunton Transit Authority (GATRA)
- Lowell Regional Transit Authority (LRTA)
- Martha's Vineyard Transit Authority (VTA)
- Merrimack Valley Transit Authority (MVRTA)
- MetroWest Regional Transit Authority (MWRTA)
- Montachusett Regional Transit Authority (MART)
- Nantucket Regional Transit Authority (NRTA)
- Pioneer Valley Regional Transit Authority (PVTA)
- Southeastern Regional Transit Authority (SRTA)
- Worcester Regional Transit Authority (WRTA)

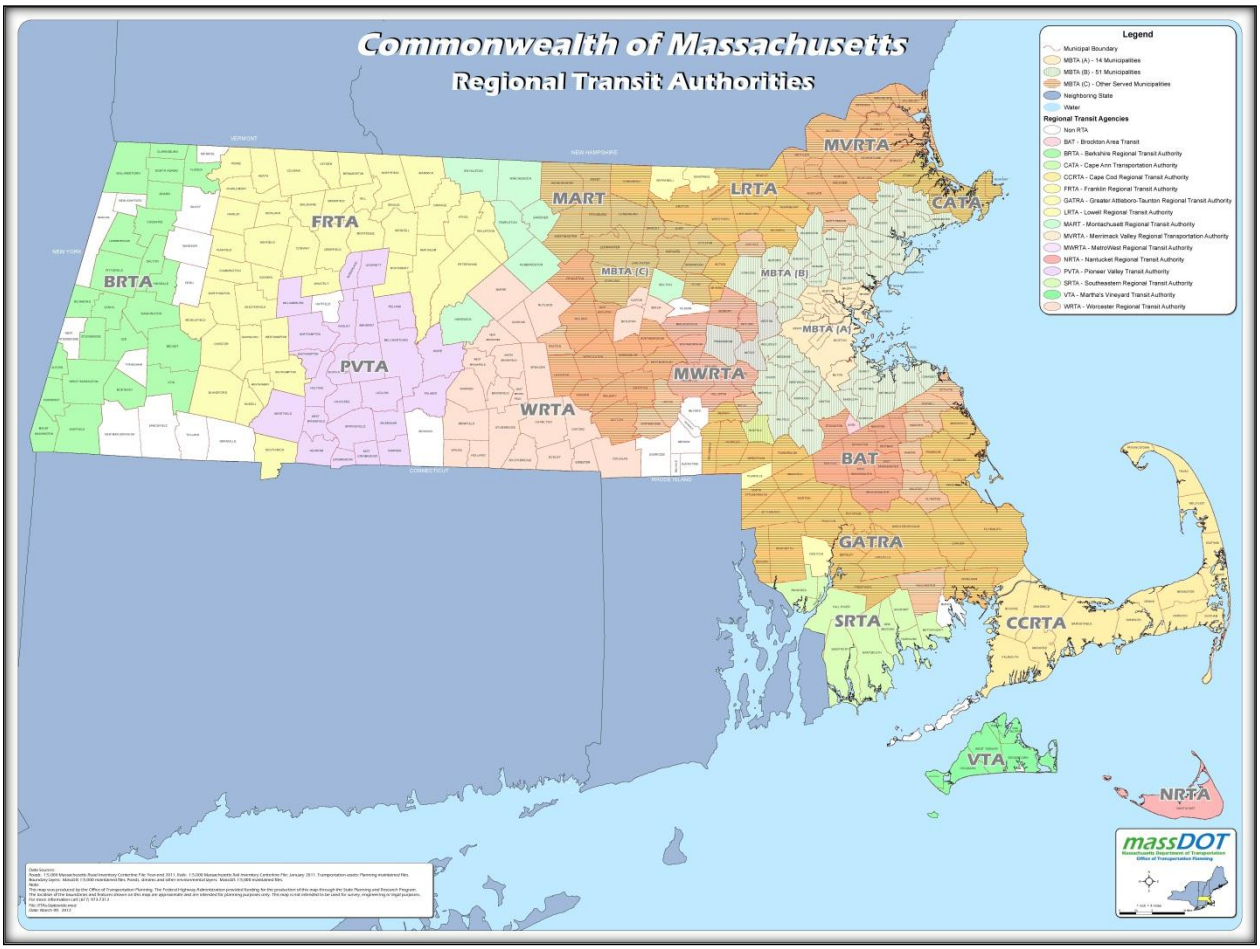
The areas they serve are shown on the map in Figure 1-4[63].

[61] Astrid Glynn, "Fixing Transit Finance: A Framework for Discussion," A Better City Research Paper, April 2011.

[62] Massachusetts Department of Transportation, *RTA ScoreCard*, December 2009. Demand response service includes paratransit.

[63] Massachusetts Department of Transportation, Massachusetts Regional Transit Authorities - Transit Division, http://www.massdot.state.ma.us/transit/RegionalTransitAuthorities.aspx

Figure 1-4: Massachusetts Regional Transit Authorities



Source: MassDOT, Office of Transportation Planning

Perhaps one of the most unique types of transit in Massachusetts is ferryboats. Ferry ridership only accounts for a small fraction of MBTA's ridership; however, it is an important component to the tourism industry. Several other ferry operators offer services in Massachusetts in addition to MBTA. These operators include the Steamship Authority, six municipalities, as well as a handful of private companies that operate ferry services. Many of these services are seasonal, operating only in summer months[64].

Additionally, Massachusetts is located along Amtrak's Northeast Corridor (NEC), which provides intercity passenger rail in Massachusetts and throughout the Northeast. Within the Commonwealth, there are approximately 56 trains operating daily and serving 11 stations: Amherst, Boston-Back Bay, Boston-North Station, Boston-South Station, Framingham, Haverhill, Pittsfield, Route 128 (Boston), Springfield, Woburn and Worcester. In FY 2012, the total number of boardings and alightings in Massachusetts was 3.13 million, a 5.7% increase from the year

[64] Massachusetts Department of Transportation, *Passenger Ferry Transportation in Massachusetts*, 2012.

prior[65]. This rail network is also a part of the Knowledge Corridor which connects several rail lines in New England. MassDOT was awarded $70 million by the Federal Railroad Administration to rehabilitate 49 miles of track and construct two stations in Western Massachusetts. This project complements other projects in the region, improving service in the corridor[66].

Freight Rail

The freight railroads in Massachusetts span the state, moving a variety of commodities, including paper/pulp, miscellaneous mixed shipments, chemicals, waste/scrap, and food/kindred products[67]. The network of companies includes thirteen freight rail operators: one class I operator, five regional railroads, four short line railroads, and two terminal line railroads.

Class I (CSX Transportation)

Regional operators (Pan Am Railways, Pan Am Southern, Providence and Worcester, New England Central Railroad and Connecticut Southern Railroad)

Short line railroads (Grafton and Upton Railroad, Bay Colony Railroad, Housatonic Railroad, Pioneer Valley Railroad and Massachusetts Coastal Railroad)

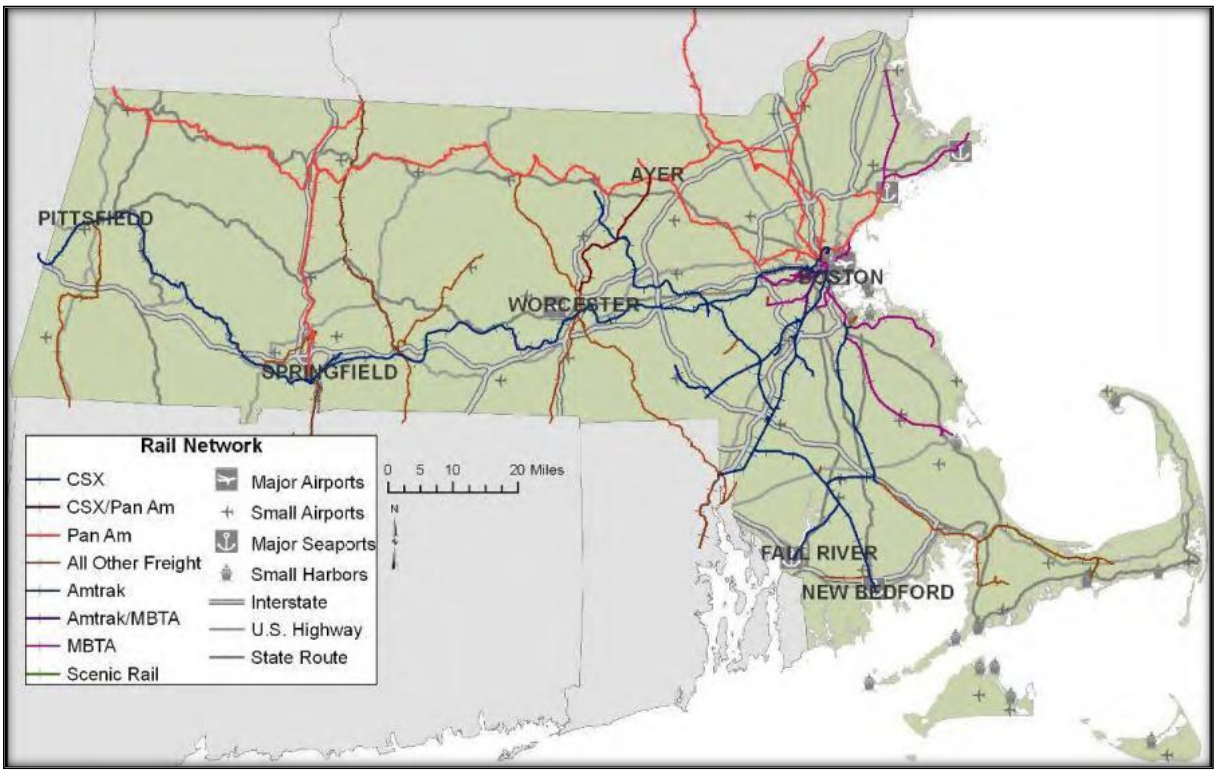
Terminal line railroads (East Brookfield & Spencer Railroad and Fore River Transportation Corporation)

Like passenger rail, freight is also connected to the Northeast Corridor (NEC)[68].

The freight shipped by rail in Massachusetts totaled 6.5 billion ton-miles in 2010 with a value of $4.8 billion (in 2007 dollars). By 2040, the volume is expected to grow by 65.1% to 10.8 billion ton-miles. The value is expected to grow by 87.3% to $8.96 billion (in 2007 dollars)[69].

[65] Amtrak, "Amtrak Fact Sheet, Fiscal Year 2012 – State of Massachusetts," November 2012. http://www.amtrak.com/pdf/factsheets/MASSACHUSETTS12.pdf
[66] Massachusetts Department of Transportation, *Freight Plan*, 2010, p. ES-28.
[67] Ibid. p. 3-15.
[68] Massachusetts Department of Transportation, Massachusetts Regional Freight Rail Operators - Transit Division, http://www.massdot.state.ma.us/transit/RegionalFreightRailOperators.aspx
[69] Federal Highway Administration, *Freight Analysis Frame Work*: FAF3.4 State summary by Dmsmode and Trade, 2040.xlsx.

Figure 1-5: Massachusetts Rail Network



Source: Massachusetts Department of Transportation Freight Plan, September 2010

Ports

The Port of Boston is the largest of Massachusetts' seaports, serving three major industries: containerized cargo, vacation cruises and Boston's commercial fishing fleet, as well as hosting privately-owned petroleum and liquefied natural gas terminals, among other operations. Conley Terminal serves several large container lines, handling nearly 1.5 million metric tons of containerized cargo each year and approximately 10 million metric tons of bulk cargo[70].

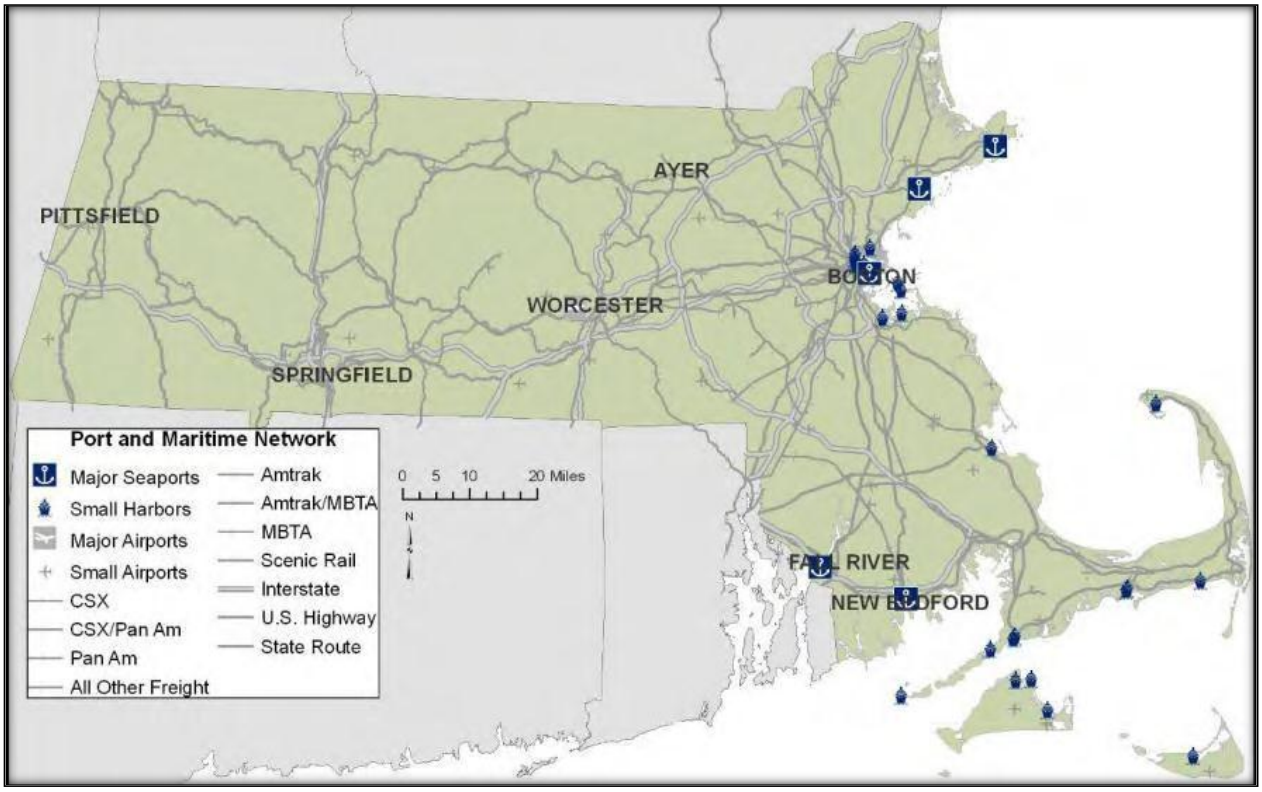
Cruiseport Boston serves more than 300,000 passengers annually to a variety of destinations. The port is a major economic hub to the region, contributing more than $2 billion to the local, regional and national economies through direct, indirect, and induced impacts[71].

In addition to the Port of Boston, the other Massachusetts compact ports are Gloucester, which primarily handles fish and fish products; Salem, which primarily handles coal and oil; New Bedford, which primarily handles household goods and perishables including fish; and Fall River, which handles fish, vehicles, heavy equipment, chemicals, liquid latex, coal and petroleum products[72]. The 18 additional ports and harbors in Massachusetts primarily serve recreational

[70] Massport, Port of Boston, http://www.massport.com/port-of-boston/
[71] Ibid.
[72] Massachusetts Department of Transportation, *Freight Plan*, 2010, p. 91.

boaters and the commercial fishing industry, as well as hosting several ferry boats and sightseeing tours[73].

Figure 1-6: Massachusetts Port and Maritime Network



Source: Massachusetts Department of Transportation Freight Plan, September 2010

In addition, Massachusetts is in a position to participate in short-sea shipping opportunities, which typically can be cost-competitive with trucking only if the beginning and ending points are 400 miles or more apart. For example, a route between Massachusetts and Maine is unlikely to prove to be cost-competitive. However, Massachusetts is located along one of the more promising routes proposed to date, including the M-95 Corridor between New Bedford, MA and Port Canaveral, FL, as shown on the map in Figure 1-7. Short-sea shipping remains significantly underused as a cost-effective alternative for goods movement.

[73] World Port Source - Massachusetts, United States, "WPS Map of Ports in Massachusetts," http://www.worldportsource.com/ports/USA_MA.php

Figure 1-7: U.S. Marine Highway Corridors

Source: MARAD

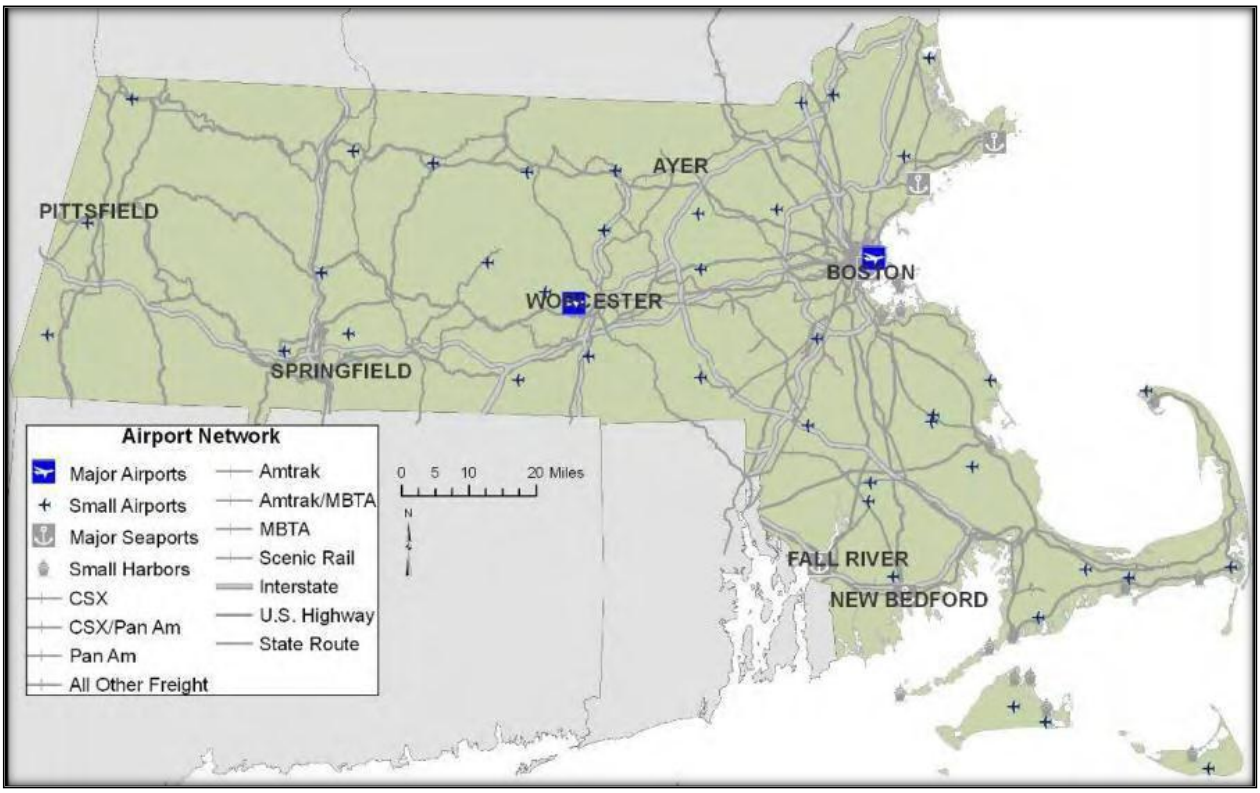
Aviation

Massachusetts is home to 30 commercial and nine general aviation airports, as shown on the map in Figure 1-8[74]. The largest airport in the New England region is Logan International Airport located in Boston, which served 28.9 million passengers in 2011[75] and generates more than $7 billion in economic activity each year[76]. In 2004, the FAA projected that Logan International Airport could see as much as 4.4% average annual growth in passenger traffic through 2020[77].

[74] Department of Transportation, *Massachusetts Statewide Airport Economic Impact Study, Executive Summary*, 2010, p. 2.
[75] Massport, Airport Statistics, *Logan Statistics for 2011 (December)*, 2011.
[76] Massport, *About Logan*, 2013. http://www.massport.com/logan-airport/about-logan/Pages/Default.aspx
[77] Federal Aviation Administration, *New England Region Airport System Plan*, 2006.

In addition to passenger movement, Massachusetts airports also move freight. Air freight in Massachusetts currently constitutes about 0.1% of all freight tonnage in the state, however it carries 5.5% of the value. It is projected to be the fastest-growing mode of freight transportation in Massachusetts over the next 25 years, increasing its volume by up to five times its current level[78]. The majority of air freight (in terms of value) travels to/from Logan International Airport, and totaled $8.8 billion in 2007[79].

Figure 1-8: Massachusetts Airport Network



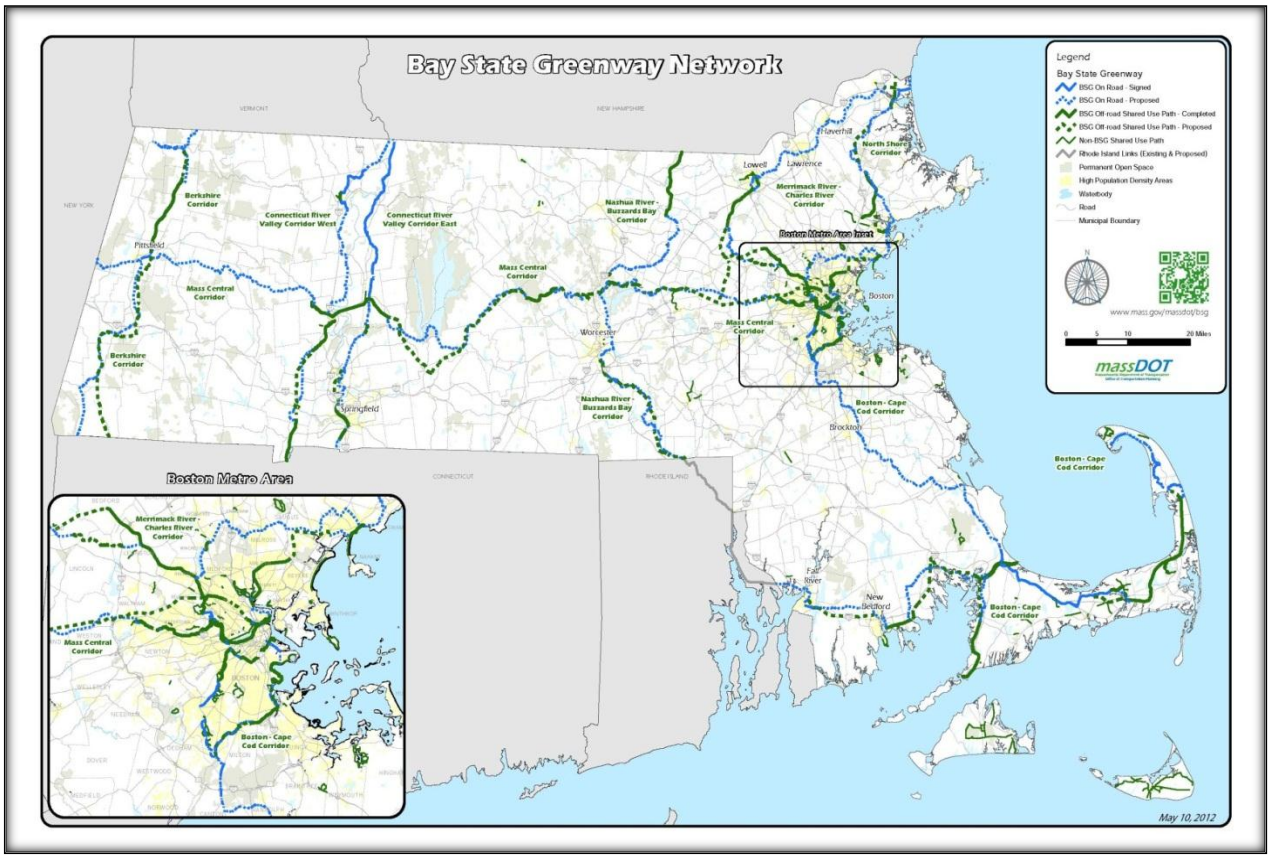
Source: Massachusetts Department of Transportation Freight Plan, September 2010

[78] Massachusetts Department of Transportation, *Freight Plan*, 2010, pp. 2-143.
[79] Ibid, p.2-146.

Bike and Pedestrian Facilities

The Commonwealth of Massachusetts is currently developing the Bay State Greenway (BSG) network, with the goal of eventually designating 788 miles of shared-use paths for bicycles. The seven-corridor system includes both on-road and off-road shared-use paths and currently includes more than 30 different shared use paths totaling 152 miles. The map below shows the network's existing and proposed paths throughout the state[80].

Figure 1-9: Massachusetts Bay State Greenway Network



Source: MassDOT

[80] Massachusetts Department of Transportation, *Bicycling in Massachusetts*, 2012.

CHAPTER 2:
DIRECT ECONOMIC IMPACT OF MASSDOT AND MBTA ACTIVITIES

This chapter discusses the direct economic impacts of transportation investments and expenditures in the Commonwealth of Massachusetts. It examines the historical trend in employment and earnings that has occurred to date, as a result of Massachusetts Department of Transportation (MassDOT) and Massachusetts Bay Transportation Authority (MBTA) expenditures. The impacts highlighted in this chapter represent those jobs and earnings supported and created by previous MassDOT capital and operating expenditures, not future impacts. However, the impacts shown in this chapter provide an indication of the potential job and earnings impacts of future MassDOT expenditures, if expenditure levels remain at historic levels.

The employment and earnings impacts described in this chapter include those that result from:

- **Capital impacts**. Construction expenditures incurred for transportation assets, including highways, transit, aeronautics and the Central Arterial Tunnel project between 2007 and 2012 that created new jobs and expanded payrolls for the duration of each project's construction cycle. The capital expenditures include construction and project/program management (soft costs such as engineering, planning, design, administration and management). These impacts are temporary, and vary from year to year based on capital budget expenses.
- **Operations and maintenance impacts**. Operations and maintenance expenses incurred by MassDOT and MBTA between 2007 and 2012 that created and sustained jobs and payrolls in Massachusetts. The operating and maintenance expenditures include the direct MassDOT and MBTA employment as well as the local purchases of goods and services necessary to operate and maintain each division. Unlike the one-time capital impacts, these operations and maintenance jobs and earnings impacts generally are considered to be recurring impacts that occur as long as the transportation system continues to operate at its current levels. Should maintenance expenditures decline, these impacts would diminish.

The capital and operating impacts associated with the Commonwealth's transportation activities represent the direct effects of the MassDOT and MBTA transportation expenditures. The purchases associated with MassDOT and MBTA capital projects and general operations stimulate demand for support industries. As a result, a further increase of new employment across a variety of supporting industrial sectors and occupational categories occurs as employers hire to meet this increase in local demand. Additionally, the earnings of these newly-hired construction and operations and maintenance workers translate into a proportional increase in consumer demand, as

these workers purchase goods and services throughout the region. This latter hiring represents the indirect and induced impacts associated with MassDOT and MBTA expenditures.

The direct, indirect, and induced economic impacts associated with MassDOT and MBTA capital projects and operations and maintenance are measured by using regional multipliers from the Bureau of Economic Analysis (BEA) within the U.S. Department of Commerce. Derived from the Regional Input-Output Modeling System (RIMS II), the RIMS II multipliers measure the total change (direct + indirect + induced effects) in employment and earnings that result from an incremental change in final demand for a particular industry. The multipliers are based on the 2010 Annual Series accounts data for the Commonwealth of Massachusetts; they represent the most up to date version available at the time this analysis was prepared.

Capital Impacts

The Commonwealth of Massachusetts' transportation capital expenditures are made through the MassDOT and MBTA and have a significant impact on the Commonwealth's economy. For every dollar in transportation capital investment spending (construction), Massachusetts delivers $2.04 dollars in output, due to the multiplier effects. In addition, this change in spending and output supports direct, indirect and induced employment and earnings. Direct employment and earnings consist of the construction-related employment and earnings in industries whose jobs and services are directly purchased for the projects. Indirect economic impacts are created by the secondary demand for goods and services across a broader spectrum of industrial sectors to support the organizations/personnel providing the construction services; while, induced economic impacts are created as direct and indirect employees spend their wages on goods and services throughout the Commonwealth. This section estimates the number of total jobs and earnings (direct + indirect + induced) that have been generated in Massachusetts based on historic MassDOT and MBTA capital expenditures.

Capital Expenditures

Massachusetts' transportation capital expenditures discussed in this chapter include:

- MassDOT
    - Highways
    - Transit & Rail
    - Aeronautics
    - Office of the Secretary
    - Central Artery Tunnel

- MBTA
    - Bus
    - Heavy Rail
    - Commuter Rail
    - Light Rail
    - Demand Response
    - Trolleybus
    - Ferryboat

MassDOT provided capital cost estimates for each division for 2007 through 2012. Additionally MassDOT provided the National Transit Database (NTD) Transit Profiles for the MBTA through 2011, which contained the historic capital costs for the transit agency. The capital expenditures are in year-of-expenditures (YOE) dollars and are summarized below by agency.

Table 2-1: Historic Massachusetts Transportation Capital Expenditures (in millions of YOE dollars)

Transportation Capital Expenditures (in millions of YOE dollars)						
	2007	**2008**	**2009**	**2010**	**2011**	**2012**
MassDOT	$ 1,119.37	$ 1,110.93	$ 1,317.96	$ 1,594.32	$ 1,495.22	$ 1,603.31
Highways	*$ 825.25*	*$ 949.82*	*$ 1,169.81*	*$ 1,392.16*	*$ 1,358.75*	*$ 1,420.63*
Transit	*$ 21.18*	*$ 34.39*	*$ 56.74*	*$ 88.17*	*$ 46.69*	*$ 60.62*
Aeronautics	*$ 5.73*	*$ 6.74*	*$ 9.03*	*$ 5.84*	*$ 16.08*	*$ 13.82*
OOTS	*$ 39.61*	*$ 45.39*	*$ 39.01*	*$ 60.59*	*$ 69.14*	*$ 81.90*
CAT	*$ 227.60*	*$ 74.60*	*$ 43.37*	*$ 47.56*	*$ 4.56*	*$ 26.34*
MBTA	$ 551.40	$ 402.93	$ 525.14	$ 389.40	$ 397.44	$ -
Total	**$ 1,670.77**	**$ 1,513.86**	**$ 1,843.10**	**$ 1,983.72**	**$ 1,892.66**	**$ 1,603.31**

Source: MassDOT (Gross Expenditures.xlsx) and NTD Transit Profiles for MBTA

Table 2-1 shows the capital expenditures on MassDOT and MBTA projects for each year 2007 through 2012 in millions of year-of-expenditure dollars. MassDOT expenditures are broken down by transportation mode or project.

The economic impact of these expenditures (measured here in terms of jobs and earnings) varies significantly by activity and depends on the amount of locally produced goods and services embodied in the purchases. Construction goods and services and professional services (soft costs) are largely purchased in the local economy. Although not every building material or engineer required for the improvements is produced in Massachusetts, the RIMS II multipliers reflect the supplier linkages for the industry, and thus account for this leakage from the Commonwealth's economy.

Capital Jobs and Earnings Effects

RIMS II multipliers are used to translate the Massachusetts transportation capital expenditures shown in Table 2-1 into the associated job and income effects. The RIMS II final demand multipliers for the construction and professional services industries are used in this analysis because the majority of the capital expenses are costs associated with construction (project or program costs) or professional/technical services (design, engineering, administrative/management costs). These multipliers are shown in Table 2-2 for the Commonwealth of Massachusetts and are described below the table.

Table 2-2: RIMS II Capital Multipliers for Massachusetts (2010/2010)

RIMS II Final Demand Multipliers		
	Earnings	**Employment**
Construction	0.6781	14.3615
Professional Services	0.7643	13.7603

Source: Bureau of Economic Analysis, U.S. Department of Commerce

Table 2-2 shows the 2010 RIMS II Capital Final Demand Multipliers for earnings and employment for both the construction and professional services industries.

The **Final Demand Earnings Multiplier** represents the total dollar change in earnings of households employed by all industries for each additional dollar of output delivered to final demand by the construction and professional services industries.

The **Final Demand Employment Multiplier** represents the total change in the number of jobs that occur in all industries for each $1 million of output delivered to final demand (in 2010 dollars) by the construction and professional services industries.

Applying the final demand multipliers for the construction and professional services industries to the annual construction and project management expenditures provides estimates of the earnings and employment impacts generated by the various MassDOT and MBTA capital projects in Massachusetts. The employment results are summarized in Table 2-3, and the earnings results are summarized in Table 2-4. It should be noted that the jobs created in each year only last for that year. In other words, one job is defined as a job for one person of one year's duration (i.e. one person-year job).

Table 2-3: Massachusetts Transportation Capital Expenditure Employment Impacts, 2007-2012 (in job-years)

Capital Employment (Job-years)						
	2007	**2008**	**2009**	**2010**	**2011**	**2012**
MassDOT	16,079	15,856	18,820	22,830	21,004	22,113
Highway	*11,853*	*13,563*	*16,717*	*19,960*	*19,118*	*19,628*
Transit & Rail	*304*	*491*	*812*	*1,266*	*657*	*838*
Aeronautics	*83*	*96*	*129*	*87*	*232*	*198*
OOTS	*571*	*640*	*542*	*834*	*933*	*1,085*
CAT	*3,268*	*1,066*	*620*	*683*	*64*	*364*
MBTA	7,918	5,757	7,513	5,592	5,598	-
Total	**23,997**	**21,613**	**26,333**	**28,422**	**26,602**	**22,113**

Source: AECOM

Note: To use the final demand multiplier for employment, the construction expenditures were deflated/inflated to 2010 dollars using the GDP Capital Non-Defense Deflator and the project management expenses were deflated/inflated to 2010 dollars using the GDP Price Index Deflator because the RIMS II multipliers are based on 2010 data.

Table 2-3 shows the calculated capital employment impacts (in job-years) for MassDOT and MBTA in the years 2007 through 2012. These figures are the product of the expenditures in each category and the corresponding RIMS II employment multipliers.

Table 2-4: Massachusetts Transportation Capital Expenditure Earnings Impacts, 2007-2012 (in millions of 2012 dollars)

Capital Earnings (in millions of 2012 dollars)						
	2007	**2008**	**2009**	**2010**	**2011**	**2012**
MassDOT	$798	$788	$934	$1,134	$1,042	$1,097
Highway	*$586*	*$670*	*$825*	*$986*	*$941*	*$966*
Transit & Rail	*$15*	*$24*	*$40*	*$62*	*$32*	*$41*
Aeronautics	*$4*	*$5*	*$6*	*$4*	*$12*	*$10*
OOTS	*$33*	*$37*	*$31*	*$48*	*$54*	*$62*
CAT	*$160*	*$52*	*$31*	*$33*	*$3*	*$18*
MBTA	$388	$282	$368	$274	$274	$0
Total	**$1,186**	**$1,070**	**$1,302**	**$1,408**	**$1,316**	**$1,097**

Source: AECOM

Note: The earnings impacts were deflated/inflated to 2012 dollars using the GDP Capital Non-Defense Deflator (construction) and the GDP Price Index Deflator (project management) in order to make the results comparable across years.

Table 2-4 shows the calculated capital earnings impacts for MassDOT and MBTA in the years 2007 through 2012 in millions of 2012 dollars. These figures are the product of the expenditures in each category and the corresponding RIMS II earnings multipliers.

In the case of economic impacts generated by capital expenditures, there are no long-term effects. Construction-related impacts only last for the duration of each program's construction expense. For MassDOT and MBTA, capital expenditures resulted in $1.07 to $1.41 billion (in 2012 dollars) in earnings and between 21,613 and 28,422 person-year jobs for each year between 2007 and 2012.

Operations and Maintenance Impacts

The Commonwealth of Massachusetts' transportation operations and maintenance (O&M) expenditures are made through the MassDOT and MBTA. These O&M expenditures have a significant impact on the Massachusetts economy due to direct, indirect and induced employment that result from the O&M expenditures associated with the transportation system. Direct employment consists of operations-related employment in industries whose jobs and services are purchased directly to operate and maintain the road and transit networks. Indirect economic impacts are those that are created by the secondary demand for goods and services across a broader spectrum of industrial sectors to support the organizations/personnel providing the O&M services; while, induced economic impacts are created as direct and indirect employees spend their wages on goods and services throughout the Commonwealth. This section estimates the number of total jobs and earnings (direct + indirect + induced) that have been generated in Massachusetts based on historic MassDOT and MBTA O&M expenditures.

O&M Expenditures

Massachusetts' transportation O&M expenditures discussed in this section include MassDOT (highways) and MBTA (both in-house transportation and purchased transportation expenses). MassDOT provided historic O&M expenses for highways for 2007 through 2012. Additionally, historic MBTA O&M expenses from the MBTA Statement of Revenues and Expenses (SORE) were provided through 2012. The O&M expenditures are in year-of-expenditures (YOE) dollars and are summarized below by agency.

Table 2-5: Massachusetts Transportation O&M Expenditures (in millions of YOE dollars)

Transportation O&M Expenditures (in millions of YOE dollars)						
	2007	**2008**	**2009**	**2010**	**2011**	**2012**
MassDOT	$73.49	$136.10	$159.59	$265.93	$385.08	$290.26
MBTA	$953.00	$1,010.38	$1,105.18	$1,145.07	$1,187.71	$1,259.15
Total	**$1,026.49**	**$1,146.48**	**$1,264.77**	**$1,411.00**	**$1,572.79**	**$1,549.41**

Source: MassDOT (Hwy Oper Exp 10 Years.xlsx and 10 SORE History FY03-FY13.xlsx)

Table 2-5 shows the operating and maintenance expenditures for MassDOT and MBTA for each year between 2007 and 2012 in millions of year-of-expenditure dollars.

The economic impact of these expenditures (measured here in terms of jobs and earnings) varies significantly by activity and depends on the amount of locally produced goods and services embodied in the purchases. Roadway and transit maintenance goods and services and are largely purchased in the local economy. Although not every material required for the maintenance is produced in Massachusetts, the RIMS II multipliers reflect the supplier linkages for the industry, and thus account for this leakage from the Commonwealth's economy.

O&M Jobs and Earnings Effects

RIMS II multipliers are used to translate the Massachusetts transportation O&M expenditures shown in Table 2-5 into the associated job and income effects. RIMS II final demand multipliers for the construction and transit and ground passenger transportation industries are used in this analysis because the majority of highway O&M expenses are associated with roadway repairs, which are most similar to construction, and transit O&M expenses reflect the transit and ground passenger transportation industry. These multipliers are shown in Table 2-6 for the Commonwealth of Massachusetts and are described below the table.

Table 2-6: RIMS II O&M Multipliers for Massachusetts (2010/2010)

RIMS II Final Demand Multipliers		
	Earnings	**Employment**
Construction	0.6781	14.3615
Transit and Ground Passenger Transportation	0.7025	22.7091

Source: Bureau of Economic Analysis, U.S. Department of Commerce

Table 2-6 shows the 2010 RIMS II Operation and Maintenance Final Demand Multipliers for earnings and employment for both the construction and transit and ground passenger transportation industries.

The **Final Demand Earnings Multiplier** represents the total dollar change in earnings of households employed by all industries for each additional dollar of output delivered to final demand by the construction and transit and ground passenger transportation industries.

The **Final Demand Employment Multiplier** represents the total change in the number of jobs that occur in all industries for each $1 million of output delivered to final demand (in 2010 dollars) by the construction and transit and ground passenger transportation industries.

Applying the final demand multipliers for the construction and transit and ground passenger transportation industries to the annual O&M expenditures provides an estimate of the earnings and employment impacts generated by the operation of MassDOT and MBTA in Massachusetts. The employment results are summarized in Table 2-7, and the earnings results are summarized in Table 2-8. It should be noted that in the table below, the jobs created in each year only last for that year. In other words, one job is defined as a job for one person of one year's duration (i.e. one person-year job).

Table 2-7: Massachusetts Transportation O&M Employment Impacts, 2007-2012 (in job-years)

Operations & Maintenance Employment (Job-years)						
	2007	2008	2009	2010	2011	2012
MassDOT	1,056	1,945	2,284	3,819	5,424	4,014
MBTA	22,670	23,490	25,329	26,004	26,450	27,532
Total	**23,726**	**25,435**	**27,613**	**29,823**	**31,874**	**31,546**

Source: AECOM

Note: To use the final demand multiplier for employment, the O&M highway expenditures were deflated/inflated to 2010 dollars using the GDP Capital Non-Defense Deflator and O&M transit expenditures were deflated/inflated to 2010 dollars using the GDP Price Index because the RIMS II multipliers are based on 2010 data.

Table 2-7 shows the calculated operations and maintenance employment impacts (in job-years) for MassDOT and MBTA in the years 2007 through 2012. These figures are the product of the expenditures in each category and the corresponding RIMS II employment multipliers.

Table 2-8: Massachusetts Transportation O&M Earnings Impacts, 2007-2012 (in millions of 2012 dollars)

Operations & Maintenance Earnings (in millions of 2012 dollars)						
	2007	2008	2009	2010	2011	2012
MassDOT	$52	$95	$112	$187	$266	$197
MBTA	$728	$755	$814	$836	$850	$884
Total	**$780**	**$850**	**$926**	**$1,023**	**$1,116**	**$1,081**

Source: AECOM

Note: The highway earnings impacts were deflated/inflated to 2012 dollars using the GDP Capital Non-Defense Deflator and the transit earnings impacts were deflated/inflated to 2012 dollars using the GDP Price Index in order to make the results comparable across years.

Table 2-8 shows the calculated operations and maintenance earnings impacts for MassDOT and MBTA in the years 2007 through 2012 in millions of 2012 dollars. These figures are the product of the expenditures in each category and the corresponding RIMS II earnings multipliers.

In the case of economic impacts generated by O&M expenditures, the annual impacts are recurring effects that last as long as the existing highway and transit systems continue to be maintained at current expenditure levels. For MassDOT and MBTA, O&M expenditures resulted in $780 to $1,116 million (in 2012 dollars) in earnings and 23,726 and 31,874 person-year jobs for each year between 2007 and 2012.

Summary

Between 2007 and 2012, annual capital and O&M transportation expenditures by MassDOT and MBTA have created or supported average annual person-jobs of 53,183 and earnings of $2.19 billion (in 2012 dollars). These averages represent 1.28% of the Commonwealth's total employment and 0.61% of Commonwealth's total personal income in 2011. Construction, administration, project management, and operations and maintenance (O&M) expenditures throughout the Commonwealth have contributed to these gains. The tables below summarize the overall employment and earnings, including direct, indirect/induced, and total impacts.

Table 2-9: Summary of Massachusetts Transportation Economic Impacts, 2007-2012

Total Employment and Earnings Impacts						
	2007	**2008**	**2009**	**2010**	**2011**	**2012**
MassDOT						
Direct Impacts						
Employment (job-years)	8,790	9,132	10,839	13,680	13,580	13,419
Earnings ($2012 M)	$479	$498	$589	$744	$736	$729
Indirect Impacts						
Employment (job-years)	8,344	8,668	10,265	12,968	12,848	12,708
Earnings ($2012 M)	$371	$385	$456	$577	$572	$565
Total						
Employment (job-years)	17,134	17,800	21,103	26,648	26,428	26,127
Earnings ($2012 M)	$850	$883	$1,045	$1,321	$1,308	$1,294
MBTA						
Direct Impacts						
Employment (job-years)	21,206	20,707	23,003	22,520	22,859	20,783
Earnings ($2012 M)	$710	$668	$756	$718	$728	$597
Indirect Impacts						
Employment (job-years)	9,382	8,540	9,839	9,076	9,189	6,750
Earnings ($2012 M)	$407	$369	$426	$391	$396	$287
Total						
Employment (job-years)	30,588	29,247	32,842	31,596	32,048	27,533
Earnings ($2012 M)	$1,117	$1,037	$1,182	$1,109	$1,124	$885
Massachusetts Total						
Total Employment (job-years)	**47,722**	**47,047**	**53,946**	**58,244**	**58,476**	**53,660**
Total Earnings ($2012 M)	**$1,967**	**$1,920**	**$2,227**	**$2,430**	**$2,432**	**$2,178**

Source: AECOM

Table 2-9 shows the summary of total employment and earnings impacts for MassDOT and MBTA from years 2007 through 2012. Employment is reported in job-years, and earnings are reported in millions of 2012 dollars.

It should be noted that in Table 2-9, the jobs created in each year only last for that year. In other words, one job is defined as a job for one person of one year's duration (i.e. one person-year job).

While the annual employment and earnings impacts shown in Table 2-9 are large, they represent less than 1.5% of Massachusetts' total employment and less than 1.0% of Massachusetts' personal income.

Table 2-10: Summary of Massachusetts Transportation Economic Impacts as Percentages of State Totals, 2007-2012

Employment and Earnings Impacts as Percentages of State Totals						
	2007	**2008**	**2009**	**2010**	**2011**	**2012**
MassDOT						
Total Employment	0.41%	0.42%	0.51%	0.64%	0.63%	0.63%
Total Earnings	0.24%	0.25%	0.31%	0.38%	0.37%	0.36%
MBTA						
Total Employment	0.73%	0.70%	0.80%	0.77%	0.77%	0.66%
Total Earnings	0.32%	0.29%	0.35%	0.32%	0.31%	0.25%
Massachusetts Total						
Total Employment	**1.14%**	**1.12%**	**1.31%**	**1.41%**	**1.40%**	**1.29%**
Total Earnings	**0.56%**	**0.54%**	**0.66%**	**0.70%**	**0.68%**	**0.61%**

Source: AECOM calculations using U.S. Bureau of Economic Analysis data

Table 2-10 shows the MassDOT and MBTA employment and earnings impacts as percentages of state totals for years 2007 through 2012.

Note that all employment and earnings percentages are calculated using total Massachusetts employment and income (respectively) for the correlating years as the denominators. The only exception is 2012 where the percentages are calculated using 2011 state employment and earnings (respectively) as the denominators because the most current state-level data was 2011.

CHAPTER 3:
LITERATURE ON THE CONNECTION BETWEEN TRANSPORTATION AND ECONOMIC DEVELOPMENT

Investments in tools, information and transportation are essential to maintaining and improving the economic productivity of industries and of workers. These investments can be made by both the private and public sectors and they can be complementary. For example, the efficiency of the trucking industry is influenced by the quality and reliability of the truck (the private investment) and the degree of safety, maintenance and congestion associated with the roads on which it travels (public investment).

Productivity matters for Massachusetts—a high wage and high cost state—relative to the nation because firms are willing to pay more productive workers higher wages. When the balance between worker productivity and worker wages, tips and productivity no longer balances wages, then earnings growth and the associated living standard slows and firms begin to seek more favorable locations elsewhere for expansions and new facilities. **In short, the private sector of an economy that underinvests in its transportation system becomes less competitive over time.**

Public capital in Massachusetts—the roads, bridges, transit systems, airports, ports and railroads[81]—represents investments made in the past that support the current economy and standard of living. The existing stock must be maintained and recapitalized as elements of the network reach the end of their useful life in order for the economy to operate at its current level of service. As the system's state of good repair deteriorates, it imposes a cost on the economy in terms of rising congestion, reduced reliability and higher operating costs.

Moreover, as the economy grows—translating into greater numbers of travelers and shipments—the physical capacity of the system must grow as well. Failure to expand to accommodate the economy's growth yields a strained transportation network with rising levels of traffic congestion, potholes in roads that are patched but not rebuilt, reductions in operating speeds, and declining system reliability overall.

Economic researchers have empirically modeled this connection between public investment in the stock of transportation assets in an economy and the performance of the economy. Quantitatively measuring the economic return to public investment in transportation stock is complex because both productivity and the variety of other public capital investments and economic policies that

[81] Public capital takes many other forms as well such as schools, water and waste treatment systems, for example. The focus of this report is simply public investment in transportation infrastructure.

influence the use and broader context of the investment are difficult to measure precisely. As a result, while researchers have generally found a positive correlation between investment in transportation infrastructure and economic productivity and growth, there is less consensus about the size of the effect.

Brief Overview of the Academic Literature

Good transportation access has long been recognized as an essential condition for economic development, both domestically and in developing countries. This was a logical assertion—firms cannot grow and develop if they cannot reliably access inputs and get their products to market—but until Aschauer[82] published his work in 1989, no one had tried to statistically model the impact of public transportation investment on economic outcomes. While subsequent researchers have differed with Aschauer on his statistical approach, the work sparked considerable interest in the issue[83]. The general consensus among these later contributors confirms Aschauer's main finding that there is a positive and statistically significant relationship between transportation investment and economic performance. The breadth of this literature is too large to summarize in detail here but the table below highlights the findings from some of the main contributions to follow Aschauer's early work.

Table 3-1: Summary of Selected Studies on the Effect of Public Capital Investment on Economic Outcomes

Author	Where Estimated	Size of Impact	Dependent Variable
Aschauer, 1989a	National, US	0.24-0.39	Aggregate output
Munnell, 1990a	National, US	0.34	Aggregate output
Aschauer, 1990	States	0.22-0.37	State income per capita
Eisner, 1991	States	0.16	Gross state product
Munnell, 1990b	States	0.15	Aggregate output
Nadiri and Mamuneas, 1996	National, US	0.35 (late 1950s/1960) 0.10 (1980s)	Aggregate output

Source: David Banister and Joseph Berechman. *Transport Investment and Economic Development*, 2000; FHWA

The main conclusion from Table 3-1 is that while estimates of the magnitude vary, there is general consensus that the impact of transportation investment on the economy's productivity is real and positive. Moreover, the impact may vary over time and by type of economy, helping to explain the variety of findings in the literature.

[82] Aschauer, A.D., "Is public expenditure productive?", *Journal of Monetary Economics*, 23:2, 177-200, 1989a. See also Aschauer, A.D., "Highway capacity and economic growth," *Economic Perspectives*, 14:1, 14-24, 1990.
[83] The main critique of this early work is that the resulting estimated impact on economic output is too large to be credible. Later studies have identified a smaller impact.

Findings from the Applied Literature

The applied literature has also considered the influence of public investment on the economy.Both corporate planners and the consultants hired to search for relocation / expansion sites recognize the value of transportation infrastructure. The Annual Survey of Corporate Executives and the Annual Site Selection Consultants Survey, conducted by the *Area Development Magazine* in 2010, describes the site selection process used by both corporations and consultants.

- The 25th Corporate Survey results presented in 2011 showed that highway access and labor costs ranked as the two most important factors to consider when selecting a site for business relocation. Consistent with the past 25 years of survey results, highways were considered "very important" or "important" by 97.3% of respondents.

Labor costs were "important" or "very important" at 91%. Other important factors included tax exemptions, state and local incentives, the availability of skilled or unskilled labor, shipping costs, energy availability and costs, and availability of buildings. Railroad access, while overall is lower in importance than the aforementioned criteria, has increased in importance over the years.

- Similarly, the 26th Corporate Survey in 2011 showed that highway accessibility and labor costs are the most important factors in the site selection process, rated as "important" or "very important" by 94 and 88%, respectively. Going hand-in-hand with highway access is the proximity to major markets, which jumped in importance from 17th in 2010 to 9th in 2011. Skilled labor tied with labor costs in the 2011 survey, showing an increase in importance over the 2010 survey results.

A statewide study of highway limitations and traffic delays on the Oregon economy concluded that the economic stakes associated with investing in transportation infrastructure and services to keep up with economic and population growth were quite substantial. By 2025, the net difference between the improvement case and the status quo scenario investigated yielded $1.7 billion in total output and more than 16,000 jobs statewide[84].

In Texas, researchers have come to a similar conclusion concerning the importance of transportation investment for the economy. Focusing on pavement conditions in the state, the Center for Transportation Research's (CTR) Texas Pavement Preservation Center predicted pavement conditions would be 30% worse under TxDOT's current 2013 10-year Unified Transportation Plan when compared to a better funded maintenance program. While neither scenario returned the state's pavement to a state of good repair, the higher level of funding avoided a sharp increase in total costs for preservation and restoration, saving taxpayers $6.5 billion by 2022[85].

[84] Economic Development Research Group, "The Cost of Highway Limitations and Traffic Delay to Oregon's Economy,"2007.
[85] Texas Good Roads, *The Cost of Doing Nothing*, Infrastructure Texas, 2012.

CHAPTER 4:
COST OF UNDERFUNDING THE SYSTEM

The concept behind economic modeling is that there is one set of economic outcomes associated with the status quo level of transportation investment in Massachusetts and a second more favorable set of outcomes associated with bringing the system into a state of good repair and addressing identified system needs. A comparison of the two sets of outcomes describes the net difference in economic performance between the two funding scenarios. That difference represents the economic loss or economics benefits of not bringing the network into a state of good repair. As described in earlier chapters, under the status quo level of investment, there is a growing backlog of maintenance and capacity projects needed to meet the current needs of the economy that is resulting in declining levels of system performance. This chapter describes how the two scenarios were estimated and presents the findings. The model used does not identify improvements for bridge structure deficiencies or bike-pedestrian access; therefore, impacts associated with these programs are excluded from the analysis. Due to similar limitations, the impacts of transit and transportation capacity expansion also are not included in the model results.

HERS-ST Model

The Highway Economic Requirements System – State Version (HERS-ST) is a highway investment/performance model application developed by the Federal Highway Administration (FHWA). The model is used to analyze current highway conditions and helps determine future highway system needs. Based on engineering principles, the software simulates future highway conditions and performance levels and identifies deficiencies.

Benefits for the identified system-wide improvements are quantified using measures such as operational cost savings (auto and truck), changes in travel time, emissions, safety, vehicle miles traveled (VMT), vehicle hours traveled (VHT) and pavement conditions. In other words, the model is capable of running a variety of scenarios to analyze the effects of funding decisions, usage, and maintenance on system performance. HERS-ST, the state version of the national HERS model introduced in 1995 and used by Congress to analyze the state of the nation's infrastructure, has been used by state departments of transportation since its introduction as a pilot program in 2001. Backed by FHWA, it is a reliable source for estimating performance, costs and conditions of a state's transportation network. Version 4.5 of the HERS-ST model was used for this analysis.

State Transportation Network

HERS-ST accepts highway-section records data in the Highway Performance Monitoring System (HPMS) format. HPMS is a national highway information system that contains data on extent, use, physical and operating characteristics of the nation's highway. Each state is required to submit

HPMS data annually to be used in the *Conditions and Performance Reports* to Congress. The most up-to-date HPMS file describing the road network in Massachusetts was obtained from MassDOT.

Because it is not possible to monitor and maintain a 100 percent accurate inventory for an entire state's roadway system, a select list of roadway segments (sample sections) within the HPMS dataset is used to represent various attributes for assessing the system-wide performance and condition of the network. Limited attributes are reported for non-sample segments. Some of the important attributes reported for sample segments include the pavement roughness index, pavement condition, average annual daily traffic (AADT), directional factors, posted speed limit, and other physical characteristics such as the number of lanes, lane width, shoulder type and width. In addition, traffic forecasts (future year AADT) for the sample segments are included in the data set. Using expansion factors, the sample segments are extrapolated to give a representation of the entire state's highway and road system.

Version 4.5 of HERS-ST (currently available), is compatible with the older format for HPMS (submitted prior to 2010). FHWA is currently working on updating the HERS-ST model that is compatible with the new 2010 format of HPMS data[86]. To address the compatibility constraints, the 2009 HPMS data submitted by MassDOT was used for the analysis. It is assumed that the 2009 HPMS dataset is a good representation of the Massachusetts highway system in place.

Funding Levels

Funding levels applied in the analysis were based on MassDOT's Capital Improvement Plan (CIP)[87] for fiscal years 2011 through 2015. The CIP outlines available funding for the various infrastructure and investment types, as well as identifying unfunded needs. The available funds for FY 2011 though FY 2013 are based on the financially constrained 2010 Statewide Transportation Improvement Plan[88] (STIP) as well as MassDOT's Non-Federal Aid (NFA) Program. Available funds in FY 2014 and FY 2015 are based on historic levels of funding. Specifically, the plan allocates available funding as well as unfunded needs for interstate pavement needs, non-interstate pavement needs, bridges, safety, toll facilities, non-federal aid maintenance needs, noise barriers and shared-use paths. For HERS-ST modeling, the funds for FY 2010 were assumed to be the same as funding in FY 2011.

[86] After 2005, HPMS underwent a reassessment to ensure it met the changing business and data needs. As a result, several data additions, deletions, and definition changes within HPMS were identified and a revised format for HPMS was introduced in 2010.

[87] See Tables 4-1 through 4-8:
http://www.massdot.state.ma.us/planning/Main/StatewidePlans/CapitalInvestmentPlan.aspx

[88] The 2010 STIP is the result of MassDOT's collaboration with its regional partners, the MPOs, and reflects the projected federal capital spending for a four-year period. The 2010 STIP covers FY 2010 - FY 2013.

Two levels of funding were obtained from the CIP. The first includes funds that have already been dedicated to facility improvements in the STIP/non-federal funding. This dedicated/available funding forms the basis for Scenario 1 in the analysis.

The second level of funding in the CIP includes funding levels required/identified to meet the highway needs in the state. The identified needs represent the funding gap between projects funded through the STIP/non-federal funding and additional projects that would ensure the state's infrastructure was brought up to a state of good repair. The identified funding needs are the basis of Scenario 2.

The funding levels from the CIP are shown in Tables 4-1 through 4-8 for interstate pavement needs, non-interstate pavement needs, bridges (not including the Accelerated Bridge Program), safety, toll-funded facilities, non-federal aid maintenance, noise barriers, and shared use paths. The funds for fiscal years 2014 and 2015 are estimates based on the average of funding over the previous three fiscal years.

Table 4-1: Interstate Pavement

FY	STIP Funding	Identified Need	Gap
FY 2011	$ 69,902,860	$128,000,000	$ 58,097,140
FY 2012	$ 70,093,160	$128,000,000	$ 57,906,840
FY 2013	$ 69,149,600	$128,000,000	$ 58,850,400
FY 2014	$ 69,715,207	$128,000,000	$ 58,284,793
FY 2015	$ 69,715,207	$128,000,000	$ 58,284,793
Total	**$ 348,576,034**	**$ 640,000,000**	**$ 291,423,966**

Source: CIP Table 4-1

Table 4-2: Non-Interstate Pavement

FY	STIP Funding	Identified Need	Gap
FY 2011	$ 25,933,339	$185,000,000	$159,066,661
FY 2012	$14,910,223	$185,000,000	$170,089,777
FY 2013	$11,814,600	$185,000,000	$173,185,400
FY 2014	$17,552,721	$185,000,000	$167,447,279
FY 2015	$17,552,721	$185,000,000	$167,447,279
Total	**$ 87,763,604**	**$ 925,000,000**	**$ 837,236,396**

Source: CIP Table 4-2

Table 4-3: Bridges

FY	STIP Funding	Identified Need	Gap
FY 2011	$162,133,470	$ 305,000,000	$142,866,530
FY 2012	$140,009,120	$ 305,000,000	$164,990,880
FY 2013	$121,000,000	$ 305,000,000	$184,000,000
FY 2014	$147,282,692	$ 305,000,000	$157,717,308
FY 2015	$147,282,692	$ 305,000,000	$157,717,308
Total	**$ 717,707,974**	**$1,525,000,000**	**$ 807,292,026**

Source: CIP Table 4-3

Table 4-4: Safety

FY	STIP/NFA Funding	Identified Need	Gap
FY 2011	$ 32,071,678	$ 59,900,000	$ 27,828,322
FY 2012	$ 32,071,678	$ 59,900,000	$ 27,828,322
FY 2013	$ 32,071,678	$ 59,900,000	$ 27,828,322
FY 2014	$ 32,071,678	$ 59,900,000	$ 27,828,322
FY 2015	$ 32,071,678	$ 59,900,000	$ 27,828,322
Total	**$160,358,390**	**$ 299,500,000**	**$139,141,610**

Source: CIP Table 4-4

Notes: Safety funding based on historical funding amounts as safety is not normally programmed in advance for the STIP.

Table 4-5: Toll-Funded Facilities

FY	Available Capital (Five-Year Average)	Identified Need	Gap
Metropolitan Highway System	$ 61,195,538	$115,319,991	$ 54,124,453
Western Turnpike	$ 11,173,586	$ 53,641,860	$ 42,468,274
Tobin Bridge	$ 17,228,303	$ 17,900,000	$ 671,697
Total	**$ 89,597,427**	**$ 186,861,851**	**$ 97,264,424**

Source: CIP Table 4-5

Table 4-6: Non-Federal Aid (NFA) Maintenance

FY	STIP Funding	Identified Need	Gap
FY 2011	$ 100,000,000	$ 200,000,000	$ 100,000,000
FY 2012	$ 100,000,000	$ 200,000,000	$ 100,000,000
FY 2013	$ 100,000,000	$ 200,000,000	$ 100,000,000
FY 2014	$ 100,000,000	$ 200,000,000	$ 100,000,000
FY 2015	$ 100,000,000	$ 200,000,000	$ 100,000,000
Total	**$ 500,000,000**	**$ 1,000,000,000**	**$ 500,000,000**

Source: CIP Table 4-6

Notes: Funding based on historical levels as projects are not normally programmed in the STIP. NFA funds in the CIP include multiple categories. In the HERS-ST analysis, this category was factored to include funds for pavement and safety needs only.

Table 4-7: Noise Barriers

FY	STIP/NFA Funding	Identified Need	Gap
FY 2011	$ -	$ 5,000,000	$ 5,000,000
FY 2012	$ -	$ 5,000,000	$ 5,000,000
FY 2013	$ -	$ 5,000,000	$ 5,000,000
FY 2014	$ -	$ 5,000,000	$ 5,000,000
FY 2015	$ -	$ 5,000,000	$ 5,000,000
Total	**$ -**	**$ 25,000,000**	**$ 25,000,000**

Source: CIP Table 4-7

Table 4-8: Shared-Use Paths

FY	STIP Funding	Identified Need	Gap
FY 2011	$ 11,298,450	$ 10,000,000	$ (1,298,450)
FY 2012	$ 3,000,000	$ 10,000,000	$ 7,000,000
FY 2013	$ 1,400,000	$ 10,000,000	$ 8,600,000
FY 2014	$ 1,600,000	$ 10,000,000	$ 8,400,000
FY 2015	$ 1,600,000	$ 10,000,000	$ 8,400,000
Total	**$ 18,898,450**	**$ 50,000,000**	**$ 31,101,550**

Source: CIP Table 4-8

Notes: Funding based on historical funding amounts over three prior years of non-earmarked funds in STIP.

The funds in the CIP are in 2010 dollars. To be consistent with internal HERS-ST improvement pricing parameters, CIP values were deflated to 2008 dollars before being input in the model. Funding levels for FY 2016 through the end of the analysis period in FY 2029 were assumed to be constant in real terms and equal to those included in the CIP for FY 2015[89].

Parameters

For this analysis, the default parameters were utilized. The default parameters in HERS-ST consist of the costs of reconstruction, resurfacing, shoulder improvements, adding lanes, and realignments. Deficiency levels are sub-divided by AADT levels and defined for flat, rolling, and mountainous roads. Price indexes are included for fuel, oil, tires, maintenance, vehicles, fuel excise tax, improvement costs, maintenance costs, value of time, vehicle and inventory costs, value of life, property, and injuries, crash delay costs, and optional urban freeway costs. Further, pavement factors for the nine functional classes by flexible or rigid pavements are included. Life expectancies of pavements range from 15 to 30 years. Design period and the maximum pavement deterioration rate are optional parameters that can be adjusted.

Model Outputs

The HERS-ST model provides a variety of outputs summarizing the impacts of road improvements on performance, system conditions and users. Outputs on improvement statistics include total initial cost, lane miles improved, net residual value, average B/C ratio, total benefits, user benefits, travel time savings, operating cost savings, safety benefits, crashes avoided, injuries avoided, and lives saved. The system conditions report portion of the output summarizes operational and safety aspects of the overall system including average speed, delay, VMT, VHT, travel time costs, crash costs, injury and fatality rates, maintenance costs, and emissions costs.

Employment Estimate

The one impact that HERS-ST does not provide is an estimate of jobs gained/lost due to long-term changes in system performance. In order to estimate the job impacts, net changes in operating costs and truck travel times were allocated across industries using data from the BEA RIMS II modeling system. Industry savings were then converted to jobs using output to employment factors. The conversion from industry savings to output was not one-to-one as industry research as shown that some gains will be taken as profit, some gains will permit the industry to restructure its operations, and some gains will be realized as an expansion of economic activity.

[89] The funding scenarios applied in the HERS-ST model were developed in consultation with MassDOT to ensure they were consistent with current information.

Scenarios for HERS-ST

In order to investigate the effects of investment levels for highway infrastructure in Massachusetts, two scenarios were analyzed in HERS-ST. In each scenario funding constraints were applied to evaluate the effects on the network and economy. An overall analysis period of 20 years between 2009 and 2029 was assumed. This was further divided into four funding periods (FPs) of five years each.

Scenario 1

Scenario 1 consists of the funding levels in the CIP. The CIP was published in 2010, so the funds are in 2010 dollars, and funding in that year was assumed to be equal to funding in FY 2011. Funding for FY 2014 and FY 2015 were estimated as average of funds in FY 2011 through FY 2013, as discussed in the CIP. Funding for years FY 2016 through FY 2029 was assumed to be equal to the funding in FY 2015. The annual funds were aggregated into four funding periods, each representing five years to yield an analysis period of 20 years. Though shown below for completeness, funding levels for bridges and shared-use paths were not considered, as HERS-ST does not identify improvements relevant to bridge structure deficiencies and bike-pedestrian access deficiencies. Non-Federal Maintenance funds in the CIP are specified for structures, pavement, safety, facilities, and miscellaneous needs. As part of the analysis, this category was factored to only include pavement and safety needs. Scenario 1 funding is shown in Table 4-9. The available funds were further deflated to 2008 dollars to be consistent with HERS-ST input data.

Table 4-9: Scenario 1 Funding (in millions of 2010 dollars)

Source	Year	Interstate Pavement Needs	Non-Interstate Pavement Needs	Bridges	Safety	Toll-Funded Facilities	Non-Federal Aid Maintenance (Pavement)	Non-Federal Aid Maintenance (Safety)	Noise Barriers	Shared-Use Paths	Total
Capital Investment Plan	FY11	$69.90	$25.94	$162.13	$32.07	$90.00	$10.50	$11.75	$ -	$ 11.30	**$413.6**
	FY12	$70.09	$14.91	$140.01	$32.07	$90.00	$10.50	$11.75	$ -	$ 3.00	**$372.3**
	FY13	$69.15	$11.81	$121.00	$32.07	$90.00	$10.50	$11.75	$ -	$ 1.40	**$347.7**
	FY14	$69.72	$17.55	$147.28	$32.07	$90.00	$10.50	$11.75	$ -	$ 1.60	**$380.5**
	FY15	$69.72	$17.55	$147.28	$32.07	$90.00	$10.50	$11.75	$ -	$ 1.60	**$380.5**

Table 4-9 shows the dedicated/available funding for highway projects (as outlined in the CIP) for each fiscal year 2011 through 2015 in millions of 2010 dollars. Funds for bridges and shared-use paths were not included as inputs for the HERS-ST model runs. NFA funds were factored to only include funds relevant to pavement and safety needs for the HERS-ST model runs. Factoring is based on funding needs identified in the CIP for each category.

Scenario 2

Similar to Scenario 1 in structure, Scenario 2 estimates the benefits resulting from an increased highway investment to reflect the state of good repair needs in the Commonwealth's roadway transportation network. Highway investment outlined in the CIP under funds for indentified needs is included in Scenario 2. Values were adjusted from 2010 dollars to 2008 dollars for use in the HERS-ST model. Overall Scenario 2 results in an increased level of available funding over the analysis period. The difference between Scenario 2 and Scenario 1 funding represents the "funding gap" in the Commonwealth, as there are more maintenance and construction needs than funds available. The funds used in Scenario 2 are shown in Table 4-10.

Table 4-10: Scenario 2 Funding (in millions of 2010 dollars)

Source	Year	Interstate Pavement Needs	Non-Interstate Pavement Needs	Bridges	Safety	Toll-Funded Facilities	Non-Federal Aid Maintenance (Pavement)	Non-Federal Aid Maintenance (Safety)	Noise Barriers	Shared-Use Paths	Total
Capital Investment Plan	FY11	$128.0	$185.0	$305.0	$ 59.9	$186.9	$ 21.0	$ 23.5	$ 5.0	$ 10.0	**$924.3**
	FY12	$128.0	$185.0	$305.0	$ 59.9	$186.9	$ 21.0	$ 23.5	$ 5.0	$ 10.0	**$924.3**
	FY13	$128.0	$185.0	$305.0	$ 59.9	$186.9	$ 21.0	$ 23.5	$ 5.0	$ 10.0	**$924.3**
	FY14	$ 128.0	$185.0	$305.0	$ 59.9	$ 186.9	$ 21.0	$ 23.5	$ 5.0	$ 10.0	**$924.3**
	FY15	$ 128.0	$185.0	$305.0	$ 59.9	$ 186.9	$ 21.0	$ 23.5	$ 5.0	$ 10.0	**$ 924.3**

Table 4-10 shows the funding needs for highway projects (as outlined in the CIP) for each fiscal year 2011 through 2015 in millions of 2010 dollars. Funds for bridges and shared-use paths were not included as inputs for the HERS-ST model runs. NFA funds only relevant to pavement and safety needs were included for the HERS-ST model runs.

Results

The benefits (savings) are displayed in millions of 2008 dollars.

Table 4-11: Estimated Benefits of Funding Massachusetts' Highway State of Good Repair Needs Summary (2010-2030)

	Range of Savings (in Billions of Discounted 2008 dollars)*	
	Low	High
Travel Time Savings	$ 11.1	$ 14.9
Operating Cost & Safety Savings	$ 6.6	$ 11.1
Total Benefits	**$ 17.7**	**$ 26.0**

* Benefits shown are discounted using a 7% discount rate. Discounting adjusts for the opportunity cost of receiving benefits over time; it presents all values in a common metric, a net present value.

Table 4-11 shows the total estimated benefits in billions of discounted 2008 dollars. The value of savings varies from low to high, representing the range of expected benefits.

- By 2030, losses in highway system performance are expected to cost the Massachusetts's economy between $11.1 and $14.9 billion (in discounted 2008 dollars) in lost travel time. These costs include auto and truck travel time.
- An additional $6.6 to $11.1 billion (in discounted 2008 dollars) in auto and truck operating costs and safety benefits, which can be avoided if the highway system is in a state of good repair, would reduce household budgets for other types of spending, such as education and health-related purchases and recreational spending.
- Reductions in truck operating costs and travel times translate into the availability of faster and more reliable freight deliveries, allowing firms to operate and restructure in a more productive way. These benefits can take a variety of forms. Shippers use lower transportation costs to search for and purchase from less expensive suppliers or to deliver goods at lower costs per shipment—this either reduces the cost to the final customer, making the firm more competitive or improves the industry's profit margin (or a combined effect). Greater certainty on delivery times allows producers/shippers to keep lower inventories and maintain smaller warehousing costs, reducing their production costs. Those that use an in-house transportation fleet can reduce the size of that fleet because they need fewer vehicles for congested periods. It is estimated between 12,300 and 15,600 jobs are supported through this competitive effect by 2030.
- To the degree that the capacity of the Commonwealth's transit systems becomes constrained over the analysis period, these estimates are conservative. Should the transit system be unable to accommodate future demand, some portion of those

travelers "crowded out" of the system would likely travel by auto, adding to the demand for road system and increasing the cost of underfunding the road system.

There also are interactions among modal performance that are difficult to measure, but they are no less vital to the success of Massachusetts transportation network.

- Performance losses in transit can impose costs on highway travelers. As transit capacity is reached, more travelers will be forced onto the roads. Growing capacity constraints for the MBTA and the RTAs' inability to expand service levels, particularly in off-peak times, limit their ability to offset or serve as a relief valve for highway congestion.
- Airports and seaports in Massachusetts are gateways to the global economy. If people and goods cannot efficiently reach these gateways, the Massachusetts economy cannot grow or sell its products to a global market.
- Given that the knowledge economy is an anchor of the Massachusetts economy, the efficient movement of people is essential for it to work and compete.

CHAPTER 5:
CASE STUDIES

All regions of the state will feel the effects of the state's eroding transportation infrastructure, but the way that the impacts are experienced will vary. Western, Central and Eastern Massachusetts differ in the industrial composition of their regional economies and thus place different demands on their transportation system and thus require different types of investments to sustain and foster local business activity. For example, the western region of the state is less urbanized than other parts and thus benefits from improvements that enhance its accessibility and ability to reach a larger labor market. Such enhancements support its tourist industry as well. It also has a greater reliance on traditional manufacturing and on moving bulk commodities that are less time sensitive[90].

By contrast, the Eastern region of the state hosts the large Boston urban area and the state's economic anchor. Here, the challenge is not labor access but rather moving large numbers of people and freight in, out and through the urban center efficiently. The mobility of this urban center affects more than its own economic health, as the efficiency of the state's major sea and air gateways are affected by travel conditions in the urban core. Freight flows in this region are more likely to be just-in-time delivery for service industries and time-sensitive manufactured goods than freight in the western part of the state. The Eastern region is more diverse than Boston, however, because of the coastal economy. The southeast region has the highest share of freight-dependent jobs of any region at 51%[91]. This is due, in part, to the existence of ports in Fall River and New Bedford, and numerous inland distribution centers.

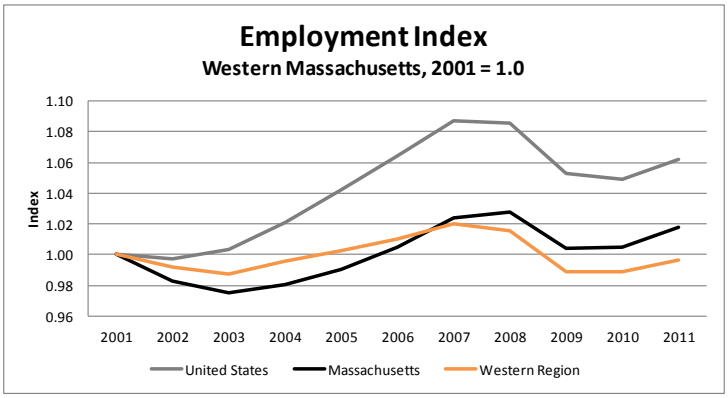
This chapter provides profiles of the state's regions and illustrates how transportation investment supports these regional economies.

Western Massachusetts

Western Massachusetts, defined in this report as the counties west of Worcester, lags the Commonwealth and US economies in job growth[92]. Per capita income for the region was just under $40,600 in 2011; the region falls just below the US per capita value of $41,560 and more than $12,000 less than per capita income for the Commonwealth as a whole, which stands at $53,470[93].

[90] MassDOT, *Freight Plan*, September 2010.
[91] Freight-dependent jobs include manufacturing, transportation and logistics employment. MassDOT Freight Plan.
[92] Those counties are Franklin, Hampshire, Hampden, and Berkshire.
[93] U.S. Bureau of Economic Analysis, Local Area Personal Income.

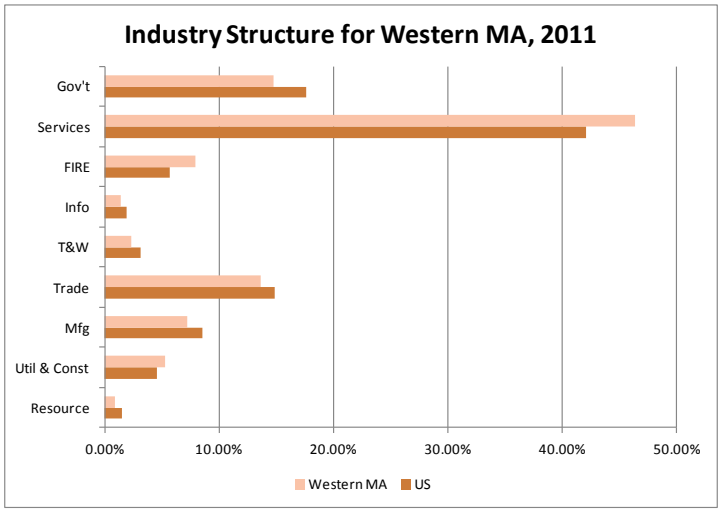
Figure 5-1: Job Growth in Western Massachusetts Relative to the U.S. and State



Served by Interstates 90 and 91, the most accessible airport with scheduled air carrier service for much of the region is Bradley International Airport in Hartford, Connecticut and Albany International Airport in Albany, New York. The region is also served by several general aviation airports including Barnes Airport in Westfield, which has been selected by Gulfstream as the maintenance facility for their new and largest corporate jet. The selection creates 100 new jobs in the area; Massachusetts has provided the airport with a grant to improve surface transportation access to the Barnes facility.

The industrial structure is similar to that of the US economy as a whole, but for a larger than average concentration in services and the FIRE sector (finance, insurance and real estate). Major employers in the region include University of Massachusetts-Amherst, Williams, Smith, Amherst, and Mt. Holyoke Colleges; Berkshire Medical, Holyoke and Mercy Medical Centers, Berkshire Health Systems (Hillcrest Campus) and Cooley Dickinson Hospital, Canyon Ranch and Jiminy Peak Mountain Resort, Mass Mutual Life Insurance, and several specialty manufacturers including SABIC Innovative Plastics, Yankee Candle, Berry Plastics, OMG Inc. (roofing products), Hasbro Games, and L.S. Starrett Company (precision tools).

Figure 5-2: Services and FIRE Have Higher than Average Shares of Western Region Employment



Lagging job growth and a much lower per capita income that limits economic opportunity relative to the balance of the Commonwealth's economy have led to a regional "brain drain" as young graduates and professionals leave the region in search of more favorable labor markets. A striking result of the 2002-03 "Knowledge Corridor" studies was that 45% of graduating seniors planned to leave region[94]. Home to some of the nation's leading educational institutions

[94] Hartford-Springfield State of the Region 2012 Conference.

and a region of high quality amenities that draw significant tourist visitation each year, the region was losing its younger generation as they sought areas with greater economic opportunity.

Set against this backdrop, the focus of transportation investment in the Western region is more on fostering access rather than on providing capacity as in the eastern portion of the state. In Berkshire County, an estimated $136 million is needed to bring the road system into a state of good repair. The Berkshire RRTA estimates $5.8 million in additional operating funding is needed in order to expand service to establish evening bus service on weekdays and Saturdays, Sunday service, and increase service on selected routes including express bus service. Such service would allow night workers at the region's many health centers, resorts and educational institutions to use public transportation.

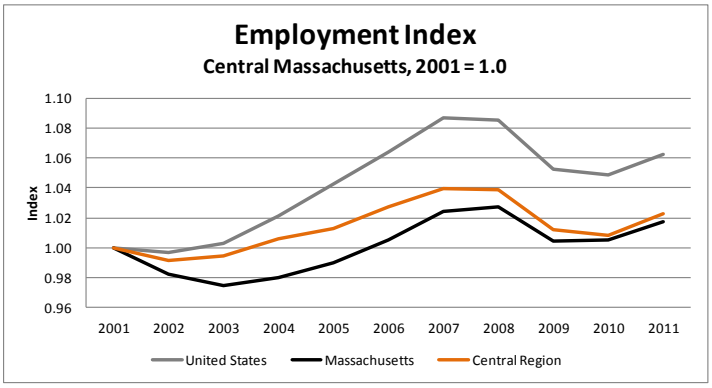
In the Pioneer Valley/Springfield area, the leading road project is the I-91 viaduct through Springfield, a $400 million project. The elevated highway, which was built in 1968, carries an estimated 60,000 to 100,000 vehicles a day. Years of patching have extended the life of the facility, but the utility of this approach is ending as potholes open up with wear, disabling vehicles, reducing speeds and causing congestion.

By promoting north-south access and ignoring state boundaries, the region is using its transportation investments to expand the diversity of economic opportunity within the functional region. For example, the Knowledge Corridor - Restore *Vermonter* Project will restore Amtrak's intercity passenger train service to its original route by relocating the *Vermonter* to its former route on the Pan Am Southern Railroad. This routing offers a shorter and more direct route for the *Vermonter* between Springfield and East Northfield, and improves access to densely populated areas along the Connecticut River. Anticipated benefits include a 25 minute reduction in travel time, an associated 24% gain in *Vermonter* ridership and greater reliability that collectively support economic revitalization and reduce traffic congestion by offering a reliable alternative. Springfield is reconstructing its historic Union Station, a focal point to a larger redevelopment initiative. Holyoke, Northhampton and Greenfield have or are planning their own intermodal facilities to leverage the rail investment. The larger benefit of this investment is that the region's residents can remain in Western Massachusetts while having access a larger and more diverse pool of employment opportunities.

Central Massachusetts

Central Massachusetts, defined in this report as the large central county of Worcester, lags the U.S. economy in job growth. The region has historically outpaced the Commonwealth in terms of job creation, but the difference in performance has narrowed since 2008 as the region's growth has decelerated. Regional per capita income stands at $45,550, well above the U.S. value of $41,560 in 2011 but still less than the Commonwealth as a whole, which stands at $53,470.

Figure 5-3: Job Growth in Central Massachusetts Relative to the U.S. and State



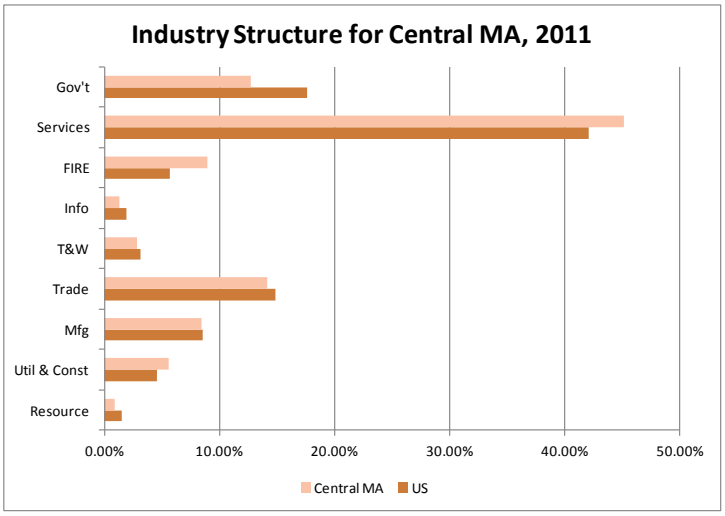
The region is served by Interstates 90, 190 and 290. The closest airports offering scheduled air carrier service is Boston Logan to the east and TF Green Airport in Rhode Island. The region is also served by numerous general aviation airports including Worcester Regional Airport in the heart of the region. Although the facility lost its only scheduled air carrier service earlier this year, Rectrix Aviation, a private jet charter company, is establishing operations that will bring more than 100 jobs to the area. The region's rail service is expanding as the MBTA increases the frequency of trains to 20 daily between the state's two largest economies: Worcester and Boston. Freight rail service will improve as well with the relocation of the existing Beacon Park CSX rail yard at Allston to expanded facilities in Westborough and Worcester. The relocation of the yard opens up the 80-acre site in the Boston area for eventual redevelopment.

The industrial structure of the region mirrors that of the nation for the most part, with smaller concentrations of government employment and slightly larger than average concentrations of services and FIRE (finance, insurance and real estate industries). Major employers in the region include: insurers Commerce Insurance Company, Hanover Insurance, and MAPFRE USA, BNY Mellon Wealth Management; and multiple educational institutions including the College of the Holy Cross, Assumption College and Clark University. The region has a growing technology base as well that includes Saint-Gobain (abrasives and ceramic materials), 3M Company, Abbott Bioresearch, Astra Zeneca, Genzyme Genetics and Allegro Micro Systems. Several health care firms also top the region's list of major employers including Affiliated Podiatrists, Community Healthlink, Milford Regional Medical Center, University of Massachusetts Memorial Medical Center and VNA Care Network.

Four industries account for 50% of the employment base in the Central Massachusetts region: Health Care, Education, Retail and Manufacturing[95]. This mix reflects the region's economic transition from reliance on traditional industries, such as manufacturing and logistics, to one that is developing its own mix of knowledge industries such as health care and education.

[95] Greater Worcester CEDS, 2012.

Figure 5-4: Multiple Large Employers in Education and Health Services Support a Larger than Average Concentration of Services



Supporting the region through this transition means sustaining the remaining existing industry but also fostering connections between the health care and education cluster in Central Massachusetts and that of Eastern Massachusetts. This regional interaction has benefits for both Worcester and Boston because as they become more integrated economically, they can begin to compete as a larger economy. It is no longer Worcester competing in the global economy or Boston competing on its own, but rather the complementary resources of both competing together. Investments such as Worcester's $32 million dollar renovation of the intermodal Union Station building is a major initiative that anchors development but also fosters a connection with Boston. The MBTA currently operates 13 round-trip trains per day between Union Station and Boston, with more to be added in the future. This train service accommodates more than 1,000 daily passengers and provides important access to lower cost housing in Central Massachusetts for workers in Boston. The bus pavilion will have a transfer hub to service approximately 230 buses a day. The transfer station design been incorporated as part of the surrounding Innovation District.

Reinforcing the synergy between Worcester and Boston is the comparative cost structure. The overall cost of doing business in Worcester is about 13% higher than the U.S. average cost. By contrast, the comparable cost in Boston is 38% higher, meaning that a business that locates in Worcester rather than Boston enjoys a 25 percentage point margin of savings. Moreover, Worcester's unit labor cost (the cost of labor adjusted for its productivity), is among the lowest in the state.

Table 5.1: Comparative Business Costs Among Massachusetts' Metropolitan Areas

2009 Regional Relative Business Costs, U.S. = 100										
Massachusetts Regions*	Cost of Doing Business		Unit Labor Cost		Energy Cost		State & Local Tax Burden		Office Rent	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Western										
Pittsfield MA	114	15	114	14	163	17	99	125	80	79
Springfield MA	109	24	103	72	161	18	98	131	87	54
Central										
Worcester MA	113	18	105	50	161	18	98	130	94	32
Eastern										
Barnstable Town MA	118	11	114	16	205	5	99	122	85	60
Boston MA	138	2	121	4	205	5	99	118	147	3
Cambridge MA	132	3	123	3	161	18	100	113	132	5
Peabody MA	111	20	108	30	161	18	98	129	90	43

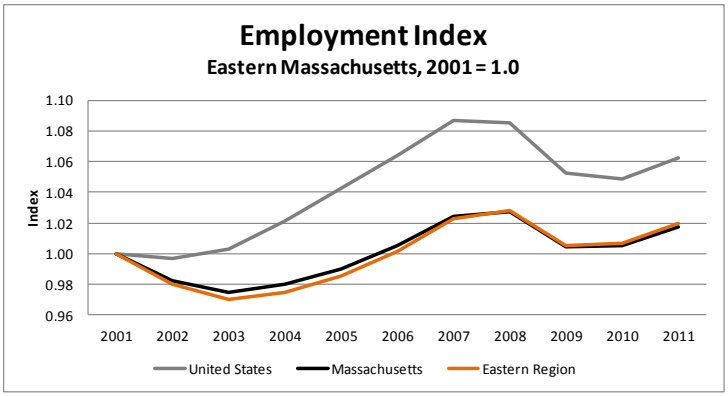
Source: Moody's Analytics. *North American Business Cost Review*. 2011 Edition

The New England Council has identified this structural cost advantage in developing its "homeshoring" (as opposed to offshoring) strategy—connecting areas of the state that have a relatively low cost of labor with industry[96]. In particular, the strategy identifies ways to combine production and distribution regions with industry and knowledge hubs to form a supply chain that creates complex products or high-value added services. This description covers most of the Central region's major employers. Because the production of the goods or provision of the service is knowledge-intensive, firms benefit from close proximity to universities and industry centers for applied research and the opportunity for learning and exchange that this offers. Transportation investments that foster this easy exchange of people and ideas supports the growth of technology firms and allows both Worcester and Boston to exploit the structural cost advantage to the Commonwealth's benefit. They also support travel between Worcester and Boston for Boston-area workers who want to take advantage of Worcester's lower housing costs.

Eastern Massachusetts

Eastern Massachusetts, defined in this report as all counties east of Worcester County, lags the U.S. economy in job growth but tracks the Commonwealth pace closely[97]. Per capita income is $56,870 for the region as a whole, over $15,000 above the U.S. per capita figure and $3,400 above the Commonwealth value in 2011. When the Boston metropolitan economy is excluded from the Eastern region figure, the per capita income figure falls slightly to $55,970, but remains well above the U.S. and Massachusetts values.

Figure 5-6: Job Growth in the Eastern Region Relative to the U.S. and State

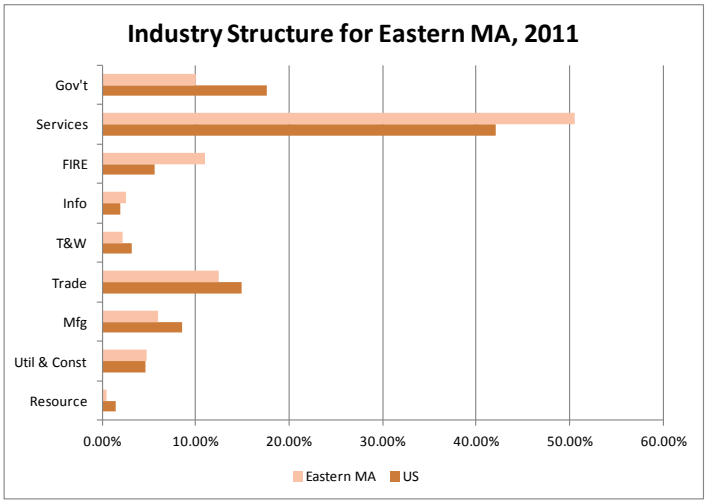


The Eastern region is served by a dense intermodal transportation network that includes Interstates 90, 93, 95 and 495, multiple seaports, and the Northeast Corridor intercity rail corridor connecting the region to the nation's economic and political centers. The region has access to scheduled air carrier service at Boston Logan Airport, Barnstable Municipal Airport, and airports in Providence, RI and Manchester, NH. The region also benefits from a dense public transit network of transit and commuter rail, buses and ferries.

[96] The New England Council and Deloitte Consulting LLP. *Smart Infrastructure in New England An investment for growth and prosperity*, October 2012

[97] The Eastern counties include Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth and Sussex.

Figure 5-7: Services and FIRE Account for Over 60 Percent of Eastern MA Employment



Services and FIRE (finance, insurance, and real estate) employment accounts for over 60% of the region's employment. Major employers in the region include: Harvard and Boston Universities and the Massachusetts Institute of Technology; health care/research centers such as Brigham & Women's, Massachusetts General, and Sinai Hospitals, the Dana Farber Cancer Institute; the Boston Red Sox; Woods Hole Oceanographic Institute; finance and insurers such as John Hancock Life Insurance, Liberty Mutual Group, MetLife and the Bank of New York Mellon, and technology firms such as Lockheed Martin MS2, Nortel Networks, Juniper Networks, EMC Corp., and Cisco Systems.

Large complex urban areas such Boston, and the associated Northeast Corridor megapolitan that it helps anchor, exist because they are focal points for commercial transactions. Urban areas provide access to large pools of labor, frequent and relatively inexpensive air transport, specialized technical and professional services, and a large client base. These factors and others provide so-called agglomeration economies that diminish the cost of transactions and make the urban area's firms more productive. Balanced against the advantages of urban size are the diseconomies of large urban areas; these negatives include higher living and business costs such as rents, crime and traffic congestion. As long as firms and households perceive that the advantages outweigh the negatives of a Boston location, firms and households will locate in the urban area, incur the costs, and the metro economy will grow and thrive. When the negatives just equal the benefits, the urban area is at its optimal size and growth will languish. When the negatives outweigh the benefits, existing businesses choose to expand elsewhere and population growth slows.

Investments to expand travel capacity or improve the travel time of public transit service reduce the negatives associated with congestion and thus influence the urban area's size and its density of people and firms—it is a critical factor influencing sensitivity to land and labor costs. Absent the ability to reliably move large numbers of specialized skilled labor in, out and within the urban economy on a daily basis such as that provided by the MBTA system, Boston's economic potential is constrained. The same idea holds true for other types of infrastructure as well. Each infrastructure investment in the overall Boston regional travel network, such as the South Coast rail project, extensions to the existing system, or improvements to the existing system that relieve bottlenecks and add capacity at core area expands the ability of the economy to manage density. These benefits are capitalized into the property values at the locations where the benefits are consumed, supporting the economic vitality of the region. The ability to offer a sustainable quality

of life is thus central to the Greater Boston area's ability to offset the costs of population and employment growth.

Boston's Regional MPO, the Central Transportation Planning Staff, have reported that the current system is already hitting capacity constraints[98].

- The MBTA Green Line Central Subway is currently operating at capacity and the Orange Line is overcrowded during peak hours in the section between Downtown Crossing and North Station.
- The Haverhill, Fitchburg, Franklin, Stoughton and Needham lines are constrained by sections of single track.
- Additional tracks are needed at South Station to accommodate service growth on south side commuter rail lines.

But more than specific points of congestion, the constraints on the system have larger implications for the development of the region. The Metropolitan Area Planning Council has analyzed the development capacity of the areas around station areas and concluded that "transit station areas could accommodate more than 76,000 new housing units and space for more than 130,000 new jobs by 2035: nearly one-third of projected housing unit growth regionwide and more than half of projected job growth.[99]" These station areas can only support this growth if the system is able to grow and support higher volumes of travelers. Put another way, constraints on the transit system's capacity will limit the market potential of station areas—increasing the likelihood that this land is underdeveloped and not used to its full potential.

Elsewhere in the Eastern Region, structurally deficient bridges in Falmouth, Dennis and Chatham are in danger of being closed because of their poor condition. The Chappaquoit Road Bridge in Falmouth is the only access route to several homes. The cities of New Bedford and Fall River do not have commuter rail service. Commuting options are limited to Route 24, which is seriously congested. A rail option would permit these lower cost communities to better integrate with the larger Eastern region economy.

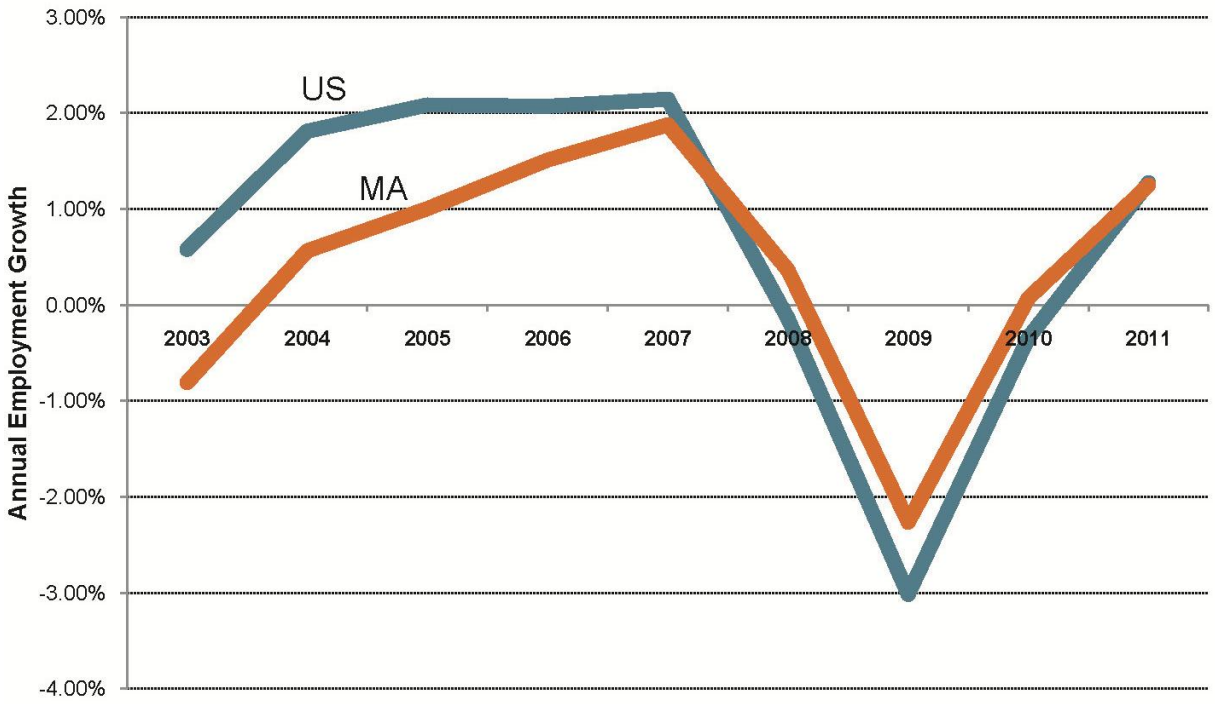
[98] CTPS, *Paths to a Sustainable Region*, Long-Range Transportation Plan, Chapter 10. Regionwide Needs Assessment.

[99] MAPC, *Growing Station Areas: The Variety and Potential of Transit Oriented Development in Metro Boston*, June 2012.

CHAPTER 6:
CONCLUSIONS

There is no doubt that the Commonwealth is recovering from the recession at a pace that is faster than the nation. As shown in the chart below, Massachusetts employment growth traditionally is more stable – exceeding national employment growth during recession years but more moderate during non-recession years. Massachusetts' job growth continues to improve as the national economy is getting back on track, and the future looks bright for Massachusetts, with employment levels in the Commonwealth projected to increase more than 15% between 2010 and 2020[100].

Figure 6-1: Comparison of Annual Employment Growth for the U.S. and State, 2003-2011



Source: U.S. Bureau of Economic Analysis

However, there is a serious problem that could stop this growth in its tracks. If Massachusetts does nothing to repair and improve its transportation infrastructure, the current recovery and potential for future economic growth could easily stall. This is not just a problem for Greater Boston. Rather it imperils jobs and economic growth throughout the entire state. Simply put, the Commonwealth's transportation network is essential to its vitality, competitiveness and quality of life.

[100] Massachusetts Labor and Workforce Development, Labor Market Information, Massachusetts Long-term Industry Projection, 2011. http://lmi2.detma.org/Lmi/Industry_Projection.asp

Massachusetts is at a crossroads.

Although Massachusetts currently has a robust, multimodal transportation network, this infrastructure is among the oldest in the U.S. and increasingly has needs for recapitalization to replace and modernize facilities and bring them up to modern design standards. The 2007 Transportation Finance Commission, an independent body of transportation experts and business and civic leaders created by statute to examine and evaluate the financial health of Massachusetts transportation agencies and authorities, concluded that the Commonwealth's transportation system had been inadequately maintained for decades. The 2007 Commission estimated that it would require at least an additional $15 to $19 billion in funding, above projected revenues, to bring its existing surface transportation system to a state of good repair and maintain it at that level[101]. It is important to note that this estimate excluded expansion in capacity and/or service levels to accommodate population and workforce growth.

Competing funding priorities and strained government coffers are limiting the resources available to maintain the existing assets in a state of good repair and to expand and upgrade the system to keep pace with the Commonwealth's economy as it grows and evolves. The Commonwealth's high level of transportation debt as compared to other states, the inability of MassDOT and the MBTA to fund their full state of good repair needs and growing operating deficits of the MBTA and Regional Transit Authorities are placing an ever increasing pressure on the transportation system.

- **State of good repair needs are growing; Massachusetts is unable to keep up with funding its current infrastructure maintenance needs.**
    - MassDOT has shown that $1 billion per year is needed for the Metropolitan Highway System Capital Maintenance Program; however, only $400 million is currently programmed annually[102].
    - Massachusetts cities and towns also face a shortfall in the ability to maintain their streets and bridges in a state of good repair. The Massachusetts Municipal Association puts the total need at $562 million/year, while Chapter 90 only provides $200 million per year – resulting in an annual shortfall of $362 million.[103]
    - MassDOT has $240 million in operating expenses being capitalized.
    - The MBTA backlog of good repair projects is at least $3 billion.

[101] Massachusetts Transportation Finance Commission, *Transportation Finance in Massachusetts: An Unsustainable System*, March 2007.
[102] Massachusetts Department of Transportation, *Capital Investment Plan FY 2011-2015*, 2010.
[103] Massachusetts Municipal Association, *MMA Study: Cities and Towns Need a Dramatic Increase in Chapter 90 Funding to Repair Local Roads*, MMA Special Report, December 18, 2012.

- The 15 state RTAs are also facing a state of good repair backlog of $150 million, largely due to an aging fleet.[104]

- **Debt service payments represent a large portion of Massachusetts' annual transportation spending.**
  - In FY 2012, 45% of the MassDOT and MBTA operating budgets will go to pay off debt.[105]
  - MassDOT receives $648 million in federal funding. Of that, $159 million (nearly 25%) immediately goes back to the federal government to pay off the "Grant Anticipation Notes" used to finance the Big Dig and the Accelerated Bridge Program.[106]
  - The MBTA is borrowing $470 million per year to cope with a state of good repair backlog that exceed $3 billion.[107]
  - The MBTA has $8.6 billion with interest in debt outstanding. $3.6 billion of this debt was inherited from the Commonwealth in Forward Funding, including the so-called "Big Dig debt" for transit commitments related to the Central Artery project.[108]
  - MBTA debt service payments were $448.2 million in FY 2012 and 30 cents of every dollar in revenue goes to pay debt. Debt service is roughly equal to fare box revenues and to the T's entire payroll.[109]

As the Commonwealth system's state of good repair deteriorates through underinvestment, it imposes a real, measurable economic loss in terms of rising congestion, reduced reliability and higher operating costs. Like a private firm, the productivity of an economy is influenced by its level of investment. Failure to maintain the system and accommodate growth yields:

- A strained transportation network with rising levels of road and transit congestion, potholes in roads that are patched but not rebuilt, disabled transit vehicles that strand travelers and declining system reliability.
- Inefficient movement of people and goods, significantly impacting productivity and costs of doing business, which results in greater uncertainty about future conditions and costs.

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[104] A Better City, *Policy Position Paper on MBTA Fare Increase*, March 2012.
[105] Transportation for Massachusetts, *Maxed Out: Massachusetts Transportation at a Financing Crossroad*, October 2011.
[106] Ibid.
[107] MBTA, MBTA Fare and Service Changes: Join the Discussion, January 2012.
[108] Ibid.
[109] Ibid.

This leads to a loss of business confidence and a reluctance to invest and expand, limiting economic development. When firms consider building new offices and factories, they are taking into account the long-term commitments to operate in that location. Rising congestion and deteriorating network reliability are signals that future business conditions may be more challenging, leading potential investors to consider other locations.

This is particularly critical in 2013, as both the local and national economies are facing an uncertain recovery. Massachusetts has proven to be resilient during the recession, and while FY 2014 shows an improving revenue picture, the state is still a long way from experiencing the level of revenue growth prior to the recession. Continued recovery and strong economic performance may be compromised by an under-maintained transportation system and the inability to expand to accommodate future economic growth—particularly as other states continue to invest in the maintenance and expansion of their transportation networks.

There is a cost to doing nothing.

When the system's physical qualities do not efficiently accommodate the movement of goods and people, performance deteriorates and imposes a cost—a severe penalty—on the Commonwealth's economy. This cost can occur through a variety of means as described below.

- Facilities that are not in a state of good repair lead to increases in operating costs for cars, trucks and railroads and increase the likelihood of crashes—translating into costs associated with property damage, injury and loss of life. By 2030, these operating and safety costs are expected to total $6.6 to $11.1 billion (in discounted 2008 dollars).

- Increased congestion translates into greater travel times, diverting valuable time from productive work or the non-work activities that support a high quality of life. By 2030, these losses in travel time are expected to cost the Massachusetts' economy between $11.1 and $14.9 billion (in discounted 2008 dollars).

- The diversion of additional resources to mitigate rising congestion and operating costs shifts resources to dealing with these problems, reducing the productivity of business in the Commonwealth. This translates into losses in income and jobs. It is estimated that between 12,300 and 15,600 jobs will be lost to Massachusetts due to its deficient highway transportation network by 2030. This is a small fraction when compared to the total size of the state's employment base, but it is equivalent to losing one of the state's largest employers nearly every year.

- Travelers' efforts to avoid highly congested points of the network—bottlenecks for example—can lead them to travel longer distances.

- Rising congestion and bottlenecks erode travel reliability, increasing the amount of time commuters and shippers must allow in order to achieve on-time delivery. Some shippers will hold higher inventories in order to compensate, raising their

overall business costs in order to compensate for the transportation system's performance.

- Deteriorating system performance translates into vehicles that are not operating at their most efficient levels—yielding environmental costs. The environmental consequences of traveling longer distances include air quality impacts, increases in greenhouse gas emissions and rising water pollution from roadway runoff.
- There is the real concern about deferred maintenance on the system and safety, but there is also an impact on the cost. Fixing the system in the near term can help Massachusetts avoid cost growth in the future. Based on historic trends, it is expected that the cost of construction will grow by 3.2% per year[110], with 10 years from now producing a compounded cost that is 37% higher than today.

This is a statewide problem.

All regions of the state will feel the effects of the state's eroding transportation infrastructure, but the way that the impacts are experienced will vary. Western, Central and Eastern Massachusetts differ in the industrial composition of their regional economies and thus place different demands on their transportation system and thus require different types of investments to sustain and foster local business activity. For example, the western region of the state is less urbanized than other parts and thus benefits from improvements that enhance its accessibility and ability to reach a larger labor market. By contrast, the Eastern region of the state hosts the large Boston urban area and the state's economic anchor. Here, the challenge is not labor access but rather moving large numbers of people and freight in, out and through the urban center efficiently.

Quantified Impacts

To help estimate the costs of not funding Massachusetts' highway 'state of good repair' needs, the Federal Highway Administration's (FHWA) Highway Economic Requirements System – State Version (HERS-ST) model was used. These costs are measured in the model as the benefits of funding the full highway maintenance state of good repair needs in Massachusetts' Capital Investment Plan FY 2011-2015 rather than maintaining the current levels of funding shown in the plan. The results of the analysis are summarized in the table below.

[110] ENR, Construction Cost Index, Average Annual Growth, 1990-2011.

Table 6-1: Estimated Benefits of Funding Massachusetts' Highway State of Good Repair Needs Summary (2010-2030)

	Range of Savings (in Billions of Discounted 2008 dollars)*	
	Low	High
Travel Time Savings	$ 11.1	$ 14.9
Operating Cost & Safety Savings	$ 6.6	$ 11.1
Total Benefits	**$ 17.7**	**$ 26.0**

*Benefits shown are discounted using a 7% discount rate.

- By 2030, losses in highway system performance are expected to cost the Massachusetts economy between $11.1 and $14.9 billion (in discounted 2008 dollars) in lost travel time. These costs include auto and truck travel time.
- An additional $6.6 to $11.1 billion (in discounted 2008 dollars) in auto and truck operating costs and safety benefits, which can be avoided if the highway system is in a state of good repair, would reduce household budgets for other types of spending, such as education and health-related purchases, and recreational spending.
- Reductions in truck operating costs and travel times translate into the availability of faster and more reliable freight deliveries, allowing firms to operate and restructure in a more productive way. These benefits can take a variety of forms. Shippers use lower transportation costs to search for and purchase from less expensive suppliers or to deliver goods at lower costs per shipment—this either reduces the cost to the final customer making the firm more competitive or improves the industry's profit margin (or a combined effect). Greater certainty on delivery times allows producers/shippers to keep lower inventories and maintain smaller warehousing costs, reducing their production costs. Those that use an in-house transportation fleet can reduce the size of that fleet because they need fewer vehicles for congested periods. It is estimated that between 12,300 and 15,600 jobs are supported through this competitive effect.
- Not only do transportation investments help us to get around safely and reliably, move needed goods and help to grow business and jobs, they also have their own economic benefits and influences. For every dollar in transportation capital investments spending, Massachusetts delivers $2.04 dollars in output, due to the multiplier effects[111].

[111] BEA, RIMS II Regional Multipliers for the Commonwealth of Massachusetts, Type II, 2010

There are limits to the quantified impact analysis. It is important to note that HERS-ST does not identify improvements for bridge structure deficiencies and bike-pedestrian access; therefore, impacts associated with these programs are excluded from the analysis. Similarly, the impacts of transit and transportation capacity expansion also are not included in these results.

There also are interactions among modal performance that are difficult to measure, but they are no less vital to the success of Massachusetts transportation network.

- Performance losses in transit can impose costs on highway travelers. As transit capacity is reached, more travelers will be forced onto the roads. Growing capacity constraints for the MBTA and the RTAs' inability to expand service levels, particularly in off-peak times, limit their ability to offset or serve as a relief valve for highway congestion.
- Airports and seaports in Massachusetts are gateways to the global economy. If people and goods cannot efficiently reach these gateways, the Massachusetts economy cannot grow or sell its products to a global market.
- Given that the knowledge economy is an anchor of the Massachusetts economy, the efficient movement of people is essential for it to work and compete.

Massachusetts economic costs beyond quantification.

Productivity matters for Massachusetts. It is a high wage and high cost state relative to the nation—because firms are willing to pay more productive workers higher wages. As shown in the table below, Massachusetts has the highest business costs in the region and among the highest in the nation.

Table 6-2: State Business Cost Comparison for Massachusetts and its Neighbors

Massachusetts and Surrounding States	Cost of Doing Business		Unit Labor Cost		Energy Cost		State & Local Tax Burden	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Massachusetts	124	1	117	1	169	3	99	19
Connecticut	113	4	99	24	183	2	111	8
New Hampshire	111	7	104	7	162	4	80	45
New York	110	9	97	29	146	8	142	1
Vermont	110	10	104	5	130	11	111	7
Rhode Island	102	14	92	39	150	6	109	9

Source: Moody's Analytics

Note: An index value of 100 means a state's costs are equal to the U.S. average. States are ranked out of 51 (50 states plus the District of Columbia). A rank of 1 is the highest cost; a rank of 51 is the lowest.

However, competitive advantages are not static. When the benefits of Massachusetts' high productivity no longer outweigh operational costs, employers' earning growth will slow and firms will seek more locations outside of Massachusetts for expansion or relocation. Additionally, while Massachusetts is struggling to keep pace with the maintenance of its transportation network, competing states are making significant transportation capacity and maintenance investments, widening the gap between the performance of these states and Massachusetts. As a result, by underinvesting in its transportation system, the Massachusetts transportation performance is eroding and the economy is becoming less competitive over time. While transportation investment is not the only component of Massachusetts' competitiveness, many of the other factors are outside of the Commonwealth's ability to influence or control. Its investment in core infrastructure, however, is directly within Massachusetts' own control.

Collectively, this loss of transportation performance threatens Massachusetts' ability to be a global competitor in coming decades.

- The health of the state's economic anchor relies on the daily efficient movement of people in and out of Boston, the urban core and economic centers throughout the state. Without an efficient transportation system, the daily flow of workers and goods to the dense urban market could not be achieved.
- Landside access to the state's marine ports and airports is critical to utilizing these gateways to the global economy. Air and marine carriers select ports (air or marine) with efficient inland distribution networks for imports.
- The efficient operation of the state's road, bridge and transit network is necessary for the Commonwealth to remain a dominant economy within the U.S. Northeast region.

ACKNOWLEDGEMENTS

The research reported herein was performed by AECOM under contract to The Boston Foundation. The project was managed by Tom Nally, Director of Planning at A Better City. Throughout the study, AECOM received invaluable technical guidance from Richard A. Dimino, President and CEO of A Better City and Keith Mahoney, Director of Public Affairs at The Boston Foundation, and research assistance from Richard Parr, Policy Director at A Better City.

AECOM also would like to thank MassDOT, especially Scott Hamwey (Project Manager, Office of Planning), Thomas Dugan (Deputy Chief of Staff) and Paul Chen (HPMS Coordinator) for their assistance with data and making time in their busy schedules to speak with us and answer our questions.

In addition, AECOM would like to thank Sheila Masters, PE (Generalist Engineer) at FHWA for providing vital technical assistance with the HERS-ST model.

DISCLAIMER